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Å. VEDEL TÅNING  
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AA. J. C. JENSEN

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# TABLE OF CONTENTS

|                                                                  | Page |
|------------------------------------------------------------------|------|
| <b>Preface</b> , by Å. VEDEL TÅNING.....                         | 7    |
| <b>Reports</b>                                                   |      |
| <b>North-Eastern Area</b>                                        |      |
| Introduction, by GUNNAR ROLLEFSEN.....                           | 8    |
| Environment.                                                     |      |
| Plankton. (Zooplankton, W. Norway) — K. GUNDERSEN.....           | 9    |
| The Fish.                                                        |      |
| Eggs and Larvae — KR. FRED. WIBORG.....                          | 11   |
| Cod — G. DANNEVIG.....                                           | 16   |
| <b>North-Western Area</b>                                        |      |
| Introduction, by Å. V. TÅNING.....                               | 18   |
| Environment.                                                     |      |
| Hydrography (N. North Atlantic) — J. SMED.....                   | 19   |
| (The Minch) — R. E. CRAIG.....                                   | 20   |
| (Myggenæs, Faroes, 1914—51) — J. SMED.....                       | 20   |
| (SW. Norwegian Sea — Westwards of Faroes) — F. HERMANN.....      | 23   |
| (Iceland Sea) — U. STEFÁNSSON.....                               | 27   |
| (Sea Temperatures and Cod Fishery) — B. RASMUSSEN.....           | 30   |
| Plankton (Scottish Investigations) — J. H. FRASER.....           | 32   |
| The Fish.                                                        |      |
| Faroes.                                                          |      |
| Eggs and Larvae — A. SAVILLE.....                                | 35   |
| 0-group Cod, Haddock, Whiting, and Coalfish — E. BERTELEN.....   | 36   |
| Haddock — R. JONES & W. MAIN.....                                | 36   |
| Lemon Sole — B. B. RAE.....                                      | 40   |
| Halibut — A. D. MCINTYRE.....                                    | 40   |
| Iceland.                                                         |      |
| Cod — J. JÓNSSON.....                                            | 41   |
| Saithe — Á. FRÍÐRIKSSON.....                                     | 42   |
| Lemon Sole — B. B. RAE.....                                      | 44   |
| Plaice — B. B. RAE & J. M. LAMONT.....                           | 45   |
| Halibut — A. D. MCINTYRE and A. SIGURÐSSON & Á. FRÍÐRIKSSON..... | 45   |
| Redfish — Á. FRÍÐRIKSSON.....                                    | 46   |
| Greenland.                                                       |      |
| Eggs and Larvae, Cod — P. M. HANSEN.....                         | 48   |
| Cod — P. M. HANSEN and B. RASMUSSEN.....                         | 50   |
| Cod Marking Experiments — B. RASMUSSEN.....                      | 53   |
| Records of Rare Fishes — B. B. RAE & E. WILSON.....              | 56   |

## Comité Atlantique

|                                                                                                                                                                                                                                                                                                                                                  | Page |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| Introduction, par J. LE GALL.....                                                                                                                                                                                                                                                                                                                | 57   |
| Les Conditions de Milieu.                                                                                                                                                                                                                                                                                                                        |      |
| Hydrologie (Mer Celtique) — J. SMED.....                                                                                                                                                                                                                                                                                                         | 58   |
| (Région NE. de l'Atlantique) — J. B. TAIT.....                                                                                                                                                                                                                                                                                                   | 62   |
| (Pertuis Breton) — R. LETACONNOUX.....                                                                                                                                                                                                                                                                                                           | 63   |
| Plancton (Investigations du R/V "Scotia") — J. H. FRASER.....                                                                                                                                                                                                                                                                                    | 65   |
| (Manche occidentale) — J. FLEURY.....                                                                                                                                                                                                                                                                                                            | 65   |
| (Zooplankton des Côtes du Maroc) — M.-L. FAURE ...                                                                                                                                                                                                                                                                                               | 66   |
| Les Poissons.                                                                                                                                                                                                                                                                                                                                    |      |
| Clupéidés: Sardine (Manche occidentale, Oeufs et Larves) — G. LEFÈVRE; (Golfe de Gascogne) — J. LE GALL et R. LETACONNOUX; (Côte Basque) — J. M. NAVAZ & F. NAVARRO; (Santander) — R. FERNANDEZ & F. NAVARRO; (Malaga) — E. BARDAN & F. NAVARRO; (Majorque) — M. OLIVER & F. NAVARRO; (Variations de Température/Migrations) — J. FURNESTIN..... | 68   |
| Thonidés: Le Thon Rouge (Golfe de Gascogne) — J. LE GALL ...                                                                                                                                                                                                                                                                                     | 82   |
| Le Germon (Golfe de Gascogne et Mer Celtique) — J. LE GALL.....                                                                                                                                                                                                                                                                                  | 83   |
| Poissons Divers: Deux Dentées du Maroc — R. COUPÉ.....                                                                                                                                                                                                                                                                                           | 88   |
| <i>Mugil chelo</i> (Côtes Marocaines) — M. ROSSIGNOL ...                                                                                                                                                                                                                                                                                         | 89   |
| <i>Trachurus</i> (Côtes Atlantiques du Maroc) — R. GAIL.                                                                                                                                                                                                                                                                                         | 90   |
| Crustacés: Crevettes (Côtes du Maroc) — CL. MAURIN.....                                                                                                                                                                                                                                                                                          | 91   |

## North Sea

|                                                                             |     |
|-----------------------------------------------------------------------------|-----|
| Introduction, by C. E. LUCAS.....                                           | 93  |
| Environment.                                                                |     |
| Hydrography (N. North Sea and Approaches) — J. B. TAIT.....                 | 94  |
| (Firth of Forth) — R. E. CRAIG.....                                         | 98  |
| (Lightvessel "Vyl") — H. THOMSEN.....                                       | 100 |
| Plankton (N. of the British Isles) — K. M. RAE.....                         | 100 |
| (Scottish Investigations) — J. H. FRASER.....                               | 104 |
| The Fish.                                                                   |     |
| Haddock (Scottish Investigations) — R. JONES & W. MAIN.....                 | 105 |
| Whiting (British Landing Statistics) — R. ELLIS.....                        | 108 |
| (The Channel) — P. DESBROSSES.....                                          | 108 |
| Plaice (British Landings) — J. A. GULLAND.....                              | 109 |
| (0-group in the Danish Waddensea — Marking Experiments) — Å. V. TÂNING..... | 111 |
| (Danish Fishery) — AA. J. C. JENSEN.....                                    | 111 |
| (Scottish East Coast) — B. B. RAE & J. M. LAMONT....                        | 113 |
| Dab (S. Horns Reef Area) — AA. J. C. JENSEN.....                            | 114 |
| Mackerel (Tagging in Norwegian Waters) — A. REVHEIM.....                    | 114 |
| Rare Fishes — B. B. RAE & E. WILSON.....                                    | 115 |

## Transition Area

|                                                             |     |
|-------------------------------------------------------------|-----|
| Introduction, by E. M. POULSEN.....                         | 117 |
| Environment.                                                |     |
| Hydrography (Danish Waters) — H. THOMSEN.....               | 118 |
| (Norwegian Coast of Skagerak) — A. DANNEVIG ...             | 119 |
| Benthic Food (Danish Waters) — J. KNUDSEN.....              | 119 |
| The Fish.                                                   |     |
| Eggs and Larvae (Gadidae, Flatfish) — J. B. KIRKEGAARD..... | 120 |
| (Sprat, Skagerak) — G. DANNEVIG.....                        | 120 |



|                                                                                                                   | Page |
|-------------------------------------------------------------------------------------------------------------------|------|
| Gadidae (Cod, Danish Waters) — E. M. POULSEN.....                                                                 | 121  |
| (Whiting, Danish Waters) — J. KNUDSEN.....                                                                        | 121  |
| (Young Fish, Cod, Norwegian Waters) — A. DANNEVIG..                                                               | 122  |
| Plaice, Flounder, and Turbot (Danish Investigations) — AA. J. C. JENSEN, E. M. POULSEN, and J. B. KIRKEGAARD..... | 122  |
| (Plaice Transplantations) — J. T. RUUD.....                                                                       | 124  |
| Dab (Danish Waters) — J. B. KIRKEGAARD and J. KNUDSEN.....                                                        | 125  |
| Mackerel — AA. J. C. JENSEN.....                                                                                  | 126  |
| Eel — AA. J. C. JENSEN.....                                                                                       | 126  |
| Fish for Processing — I. BOHUS JENSEN.....                                                                        | 126  |
| Hatching and Rearing — A. DANNEVIG.....                                                                           | 127  |
| Shellfish (Deep Sea Prawn) — E. M. POULSEN.....                                                                   | 128  |
| (Oyster and Lobster) — A. DANNEVIG.....                                                                           | 128  |
| <b>Baltic Area</b>                                                                                                |      |
| Introduction, by CHR. HESSLE.....                                                                                 | 129  |
| Environment.                                                                                                      |      |
| Hydrography (Danish Observations) — H. THOMSEN.....                                                               | 130  |
| (Swedish Observations) — F. F. KOCZY.....                                                                         | 130  |
| Plankton (Danish Observations) — AA. J. C. JENSEN.....                                                            | 132  |
| (Swedish Observations) — STEN VALLIN.....                                                                         | 132  |
| The Fish.                                                                                                         |      |
| Cod, Flatfish (Danish Observations) — AA. J. C. JENSEN.....                                                       | 133  |
| <b>Herring</b>                                                                                                    |      |
| Introduction, by Å. FRIDRIKSSON.....                                                                              | 135  |
| Reports. A. Atlantic Waters.                                                                                      |      |
| Commercial Fish (Icelandic North Coast) — Å. FRIDRIKSSON...                                                       | 136  |
| (NE. of Faroes) — Å. V. TÅNING.....                                                                               | 140  |
| (Norwegian Sea) — AA. J. C. JENSEN.....                                                                           | 140  |
| B. North Sea and Adjacent Waters.                                                                                 |      |
| Young Stages (Scottish Waters) — A. SAVILLE and G. MCPHERSON.....                                                 | 141  |
| (Bløden Ground — Clay Deep) — AA. J. C. JENSEN.....                                                               | 142  |
| Commercial Fish (Scottish Fisheries) — H. WOOD, B. B. PARRISH, I. G. BAXTER, G. MCPHERSON.....                    | 143  |
| (Dutch Fisheries) — J. DE VEEN and L. K. BOEREMA.....                                                             | 150  |
| (Belgian Fisheries) — CH. GILIS.....                                                                              | 156  |
| (French Fisheries) — J. ANCELLIN.....                                                                             | 163  |
| C. Skagerak, Kattegat, Belt Sea, and Baltic.                                                                      |      |
| Young Stages — AA. J. C. JENSEN.....                                                                              | 166  |
| Commercial Fish — AA. J. C. JENSEN.....                                                                           | 167  |
| <b>Shellfish</b>                                                                                                  |      |
| Introduction, by B. HAVINGA.....                                                                                  | 172  |
| Crustacea.                                                                                                        |      |
| Shrimp (Effect of Mesh Size) — CH. GILIS.....                                                                     | 173  |
| Mollusca.                                                                                                         |      |
| Oyster (Production and Setting of Larvae, Essex) — G. DUNCAN WAUGH.....                                           | 174  |
| (Larvae and Spatfall, Oosterschelde) — P. KORRINGA.....                                                           | 178  |
| Scallop — J. AUDOUIN & R. LETACONNOUX.....                                                                        | 180  |
| Mussel (infested by <i>Mytilicola</i> ) — P. KORRINGA.....                                                        | 182  |
| Map showing the areas and their limits.....                                                                       | 186  |

## Résumé of Subjects.

- Environment.** Hydrography: NW-A., N. Atlantic, p. 19; the Minch, p. 20; Faroes, p. 20; SW. Norwegian Sea, p. 23; westwards of Faroes, p. 27; Iceland Sea, p. 27; Sea temperatures and Cod fishery, p. 30. Cté. Atl., Celtic Sea, p. 58; NE. Atlantic, p. 62; Pertuis Breton, p. 63. North Sea, N. N. Sea, p. 94; Firth of Forth, p. 98; L.V. »Vyl«, p. 100. Tr. A., p. 118. Baltic, p. 130.
- Plankton: General. NW-A., p. 32. Cté. Atl., p. 65. North Sea, p. 100. Baltic, p. 132.
- Zooplankton. NE-A., W. Norway, p. 9. Cté. Atl., Morocco, p. 66.
- Nannoplankton. Shellfish, p. 176.
- Benthic Food: Tr. A., p. 119.
- The Fish.** Eggs and Larvae: NE-A., N. Norway, p. 11. NW-A., Faroes, p. 35; Greenland, p. 48. Cté. Atl., Manche occidentale, p. 68. Tr. A., p. 120.
- Cod: NE-A., p. 16. NW-A., Iceland, p. 30 & 41; Faroes, p. 36; Greenland, p. 50—56. Tr. A., p. 121, 122. Baltic, p. 133.
- Haddock: NW-A., Faroes, p. 36. North Sea, p. 105.
- Saithe: NW-A., Iceland, p. 42.
- Gadidae: Tr. A., pp. 120, 122.
- Whiting: NW-A., Faroes, p. 36. North Sea, p. 108. Tr. A., p. 121.
- Coalfish: NW-A., Faroes, p. 36.
- Flatfish: Tr. A., pp. 120, 122, 125. Baltic, p. 133.
- Plaice: NW-A., Iceland, p. 45. North Sea, p. 109.
- Dab: North Sea, p. 114. Tr. A., p. 125.
- Lemon Sole: NW-A., Faroes, p. 40; Iceland, p. 44.
- Halibut: NW-A., Faroes, p. 40; Iceland, p. 45.
- Herring: pp. 135—171.
- Sardine: Cté. Atl., pp. 68—82.
- Sprat: Tr. A., p. 120.
- Mackerel: North Sea, p. 114. Tr. A., p. 126.
- Tunny: Cté. Atl., pp. 82—88.
- Dentex*: Cté. Atl., Morocco, p. 88.
- Mugil*: Cté. Atl., Morocco, p. 89.
- Trachurus*: Cté. Atl., Morocco, p. 90.
- Redfish: NW-A., Iceland, p. 46.
- Rare Fishes: NW-A., p. 56. North Sea, p. 115.
- Eel: Tr. A., p. 126.
- Fish for Processing: Tr. A., p. 126.
- Hatching and Rearing: Tr. A., p. 127.
- Shellfish.** Deep Sea Prawn: Tr. A., p. 128.
- Shrimp: Cté. Atl., p. 91. Shellfish, p. 173.
- Lobster: Tr. A., p. 128.
- Oyster: Tr. A., p. 128. Shellfish, p. 174.
- Scallop: Shellfish, p. 180.
- Mussel: Shellfish, p. 182.

## Preface.

THE International Council for the Exploration of the Sea decided at its meeting in Amsterdam in October 1951 that the then General Secretary, Dr. P. JESPERSEN, with the assistance of the Council's Central Office, should take over the editorship of the *Annales Biologiques*, after his predecessor, Dr. H. BLEGVAD, who since the Council's informal meeting at Stockholm, during the war, in March 1940, until his death in 1951, had edited the seven first volumes, with Dr. AA. J. C. JENSEN as assistant editor for Volumes II to VII.

Unfortunately, owing to his illness and death, Dr. JESPERSEN was prevented from taking an active part in the preparation of the present issue. Apart from the preliminary editorship, which falls on the various Committee Chairmen, the preparation of the present issue — as that of former years — was carried out by Dr. AA. J. C. JENSEN together with Dr. MARIE REHDER and Mrs. H. HARDER of the Council's Central Office, whose good offices are greatly appreciated.

The Council Meeting at Copenhagen, in October 1952, decided that for the present the editing of this series should be continued as before, so that the Central Office is charged with the practical arrangement of the material, while I am to give advice in scientific matters. I should like to stress, therefore, that the preliminary editing of contributions received, as hitherto, rests with the Committee Chairmen who, from their full knowledge of the conditions prevailing in the areas, or of the specific subjects dealt with (herring, shellfish), are specially qualified to evaluate the contributions submitted. It will be remembered that the publication of the *Annales Biologiques* was resolved upon as a more practical continuation of the detailed administrative reports which were written by the several Committee Chairmen after the reorganization of the Council's work in 1923-25.

Due to the special circumstances under which the preceding issue (Vol. VII) appeared, there was no opportunity, in a preface, to recognize the work done by the first editor, Dr. H. BLEGVAD and his co-editor, Dr. AA. J. C. JENSEN, assisted by the Council's Central Office, in drawing up the basic scheme and in elaborating the general plan of the publication. It is a pleasant duty for me now to express the Council's appreciation of that work.

The arrangement of the material of the present issue is also made along the agreed lines; it is obvious that a clear and lucid system is necessary for the reader so that he may find the desired information quickly and surely, and follow the variations from one year to another.

In this issue, however, a small change has been introduced, in that the contributions to the southern and northern North Sea — following the reorganization plan of the Area Committees in 1950 — have been combined. This will no doubt facilitate the survey of the conditions within this area, which forms an organic unit. As in the preceding volume (VII) a report on shellfish (Crustacea and Mollusca) will be found, by the Chairman of the Shellfish Committee.

On page 2 of the cover is given, as before, the scheme for the arrangement of the material. Authors will greatly assist readers by following this scheme, which is explicit in the introductory notes, and in the general arrangement of the latest volumes.

Å. VEDEL TÅNING.



# North-Eastern Area.

## INTRODUCTION

In the waters within the North-Western and North-Eastern Areas, several countries have lately begun co-operating on a programme of research. The work was started, not only because of the ever increasing economic importance of these waters, but also because it here seems possible to achieve results of a fundamental scientific value.

The enormous transports of water which meet and mix in the Norwegian Sea and the Barents Sea are of highly different origin. In these latitudes, the seasons of the year demonstrate extreme variations both in temperature and in light conditions. Fish populations, great in numbers and in economic importance, undertake long migrations, appearing for certain periods of their lives at different localities in these areas.

The problems connected with the migrations and fluctuations of the various stocks of fish have in many ways broken the bounds of our previous conceptions. It is very likely that these problems now may be easier to select and define, when seen against the more roughly patterned background of the Norwegian Sea and the Barents Sea. Because the causes of the alterations in the ecological conditions and in the occurrence and distribution of the marine organisms may have to be sought far away from the area where they are observed, the limits of the areas required for scientific

work do not always coincide with the dividing lines drawn for the convenience of administrative and geographical purposes.

It is beyond doubt that the more flexible organization of the committees of the International Council, now put into force, and which makes the geographical borders easier to overstep, will facilitate the operations at sea and the co-operative undertakings. But it must be borne in mind that we are speaking of rather large areas of the sea and of great depths which make heavy demands both on vessels, finances and men. Increasing interest in these waters on the part of the industry can be foreseen; wishes and claims are already manifest. It is, therefore, of importance to point out the lack of balance between the tasks before us and the means of research at our disposal. It is, however, also important to stress that the confident co-operation, now established between the scientists working in these areas, is a guarantee and a sound basis for the future work.—

As a contribution to the elucidation of the problems in northern waters, the North-Eastern Area presents reports from:

GUNNAR DANNEVIG, Norway  
KAARE R. GUNDERSEN, »  
KR. FR. WIBORG, »

„GUNNAR ROLLEFSEN.



## ENVIRONMENT

### Plankton.

#### Zooplankton Investigations in Western Norway during 1950-51.

At the end of February 1950 investigations on zooplankton were initiated by the Directorate of Fisheries, Institute of Marine Research, Bergen, in some fjords south of Bergen on the west coast of Norway, where fishery for sprat, *Clupea sprattus* L., usually takes place during the summer and autumn. The main purpose of the investigations was to study the food conditions for the sprat all the year round, and the possible connection between the fat content of the plankton and of the sprat.

During 1950, five stations (A-E, Figure 1) were worked every fortnight, from the end of February to the middle of December. In 1951 the same stations were investigated every month, from the beginning of February to the beginning of May. From May to September the stations A-I (Figure 1) were worked every week.

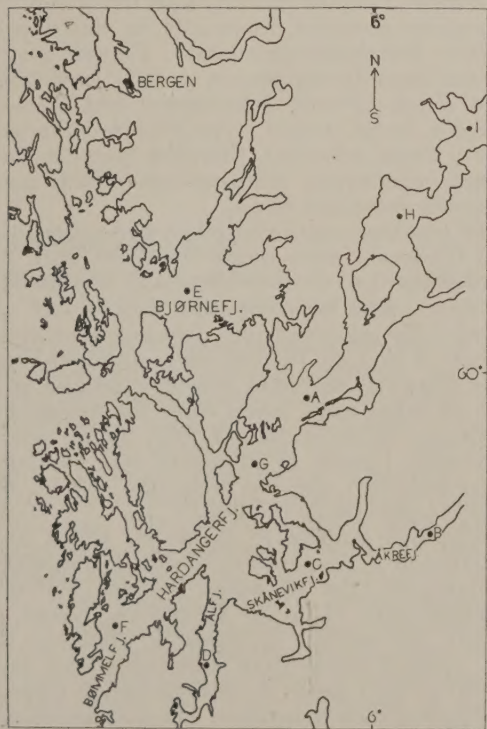


Figure 1. Chart showing Areas. • Stations.

At all stations vertical hauls with a Nansen net "8/72" were made from 50-0 m., 100-0 m., and 200-0 m. In addition, hauls were also taken at station C from 270-0 m., at stations A, B and E from 300-0 m., and at station B from 500-0 m. In order to get sufficient material for determination of the fat and protein content of the plankton, 4 additional hauls were made at all stations from 50-0 m., from the middle of May to the middle of October.

At the stations A-E temperature observations were made and water samples taken at the usual standard depths for determination of salinity and oxygen. The observations were taken every fortnight during both years and handed over to the hydrographical section of the Institute.

The volumes of all plankton samples taken during 1950 were measured by displacement. At all stations, the 50-0 m. samples were analysed as to the number of individuals and stages of development of the different species present. This was also the case with the 300-0 m. samples at station A and the 500-0 m. samples at station B.

The content of fat and protein in dry weight of the plankton samples was determined by the Research Laboratory of the Norwegian Canning Industry, Stavanger.

In Figures 2 and 3 are shown the variations of the average volume at the stations A, B, C, D, and E during 1950 and 1951. The yearly variations were quite similar in the two years. There were two maxima, one smaller spring maximum, occurring in 1950 in the middle

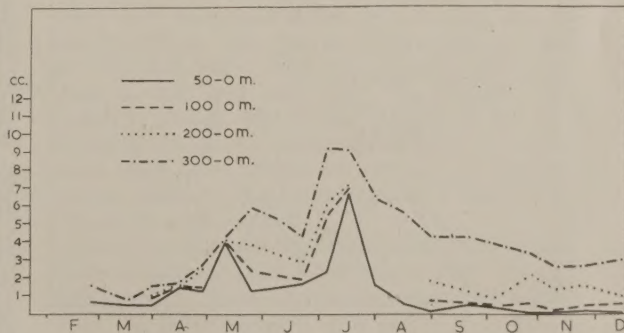


Figure 2. The variation of the average volume of plankton in the vertical hauls at the stations A-E during 1950.

of May and in 1951 in the middle of April, and one main maximum, occurring in both years in July.

In Figure 4 are shown the variations of the mean volumes of plankton, the number of organisms in the samples, and the percentages of fat and protein in dry weight of plankton during 1950. All curves have two peaks, the first one in May, and the second and higher one in July. In September, there was a slight increase in both the number of organisms and the protein percentage. It is obvious that the highest percentages of fat and protein are found simultaneously with the maxima of the total number of organisms and of the volumes of plankton. The food conditions for the zooplankton were probably very good at the same time.

Of all organisms occurring, the copepods were the most important, and of those *Calanus finmarchicus* dominated entirely and was responsible for the greater part of the plankton volumes, especially in the upper 50 metres from the middle of April to the middle of July. When *Calanus finmarchicus* was numerous we also had a high percentage of fat and protein in the plankton, with the exception of the samples from September. In September there was a rather large increase in the number of organisms, but the volumes of plankton did not increase to the same extent. At this time the smaller copepods, e.g., *Acartia* spp., *Pseudocalanus*, *Paracalanus*, *Oithona* and others occurred in large numbers, while *Calanus finmarchicus* was sparsely present.

In the deeper hauls from 300 m. to the surface the larger copepods *Pareuchaeta norvegica*, *Chiridius armatus* and *Calanus hyperboreus* were more frequent than in the hauls

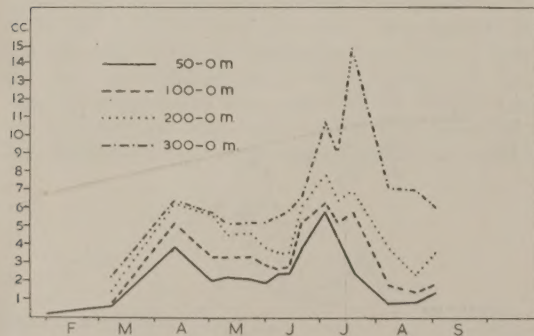


Figure 3. The variation of the average volume of plankton in the vertical hauls at the stations A-E during 1951.

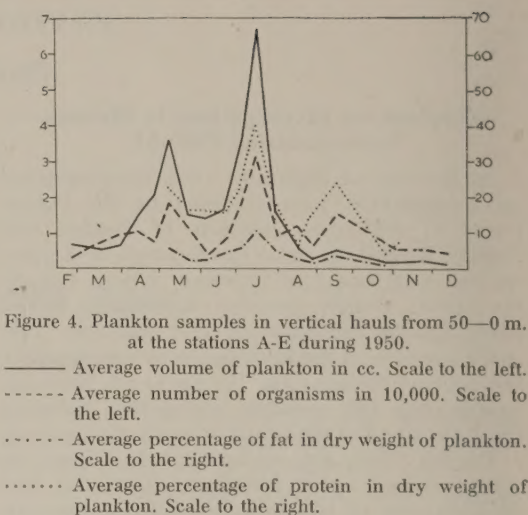


Figure 4. Plankton samples in vertical hauls from 50-0 m. at the stations A-E during 1950.

— Average volume of plankton in cc. Scale to the left.  
 - - - Average number of organisms in 10,000. Scale to the left.  
 . . . Average percentage of fat in dry weight of plankton. Scale to the right.  
 - . - Average percentage of protein in dry weight of plankton. Scale to the right.

taken from higher levels and contributed a greater part of the volume, but these species were nevertheless scarce in numbers compared with the other copepods.

Besides *Calanus finmarchicus*, the following copepods occurred frequently in the upper layers: *Pseudocalanus minutus*, *Temora longicornis*, *Paracalanus parvus*, *Acartia longiremis* and *clausi*, *Oithona helgolandica* and *Oncaea borealis*. In the deeper layers we always found *Pareuchaeta norvegica*, *Chiridius armatus*, *Calanus hyperboreus*, *Microcalanus pusillus* and *Metridia longa* and *lucens*.

Of plankton organisms other than copepods, the Cladocera were numerous from April to September, larvae of Coelenterata, Cirripedia, Mollusca and Copelata from the middle of April to the middle of July. *Limacina retroversa* occurred in July 1950 in large numbers, but was otherwise scarce or absent. Eggs and larvae of fishes were found from the middle of February to the middle of July, but in small numbers. Larvae of decapods and euphausiids occurred sparsely from the middle of April to the middle of July.

The five stations F, G, A, H, and I are situated in a longitudinal section of the Hardangerfjord, the distances between stations varying from 15 to 30 kilometres. Figure 5 shows the average volumes of plankton in the vertical hauls from 50-0 m., 100-0 m., 200-0 m. and 300-0 m. at each station during the period May-September. The corresponding plankton volumes were all increasing from the



inner to the outer part of the fjord. In the inner part of the fjord there was only little difference in volume of plankton samples taken from 50-0 m. and from 300-0 m., but this difference increased as we passed from the inner to the outer fjord. A cursory examination showed distinct differences in the composition of the plankton. In the outer fjord *Calanus finmarchicus* was dominant in the samples from 50-0 m. from the middle of April to the middle of July, but in the inner part of the fjord in July only. At other times of the year, small copepods, e.g., *Acartia*, *Pseudocalanus*, *Oithona* and *Oncaea* were numerous. In the deeper hauls, especially from 300-0 m., the larger copepods *Pareuchaeta norvegica*, *Chiridius armatus* and *Calanus hyperboreus* were much more numerous at the outer stations F, G, than at the inner stations H, I, and constituted a greater part of the plankton volume.

At the outer stations, the animals in the plankton samples were of a bright red colour.

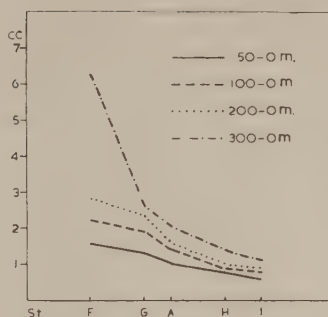


Figure 5. The average volumes of plankton at each station in the vertical hauls during the period May-September 1951.

most of the time, and filled with oil. Towards the inner part of the fjord the red colour gradually changed into a yellow-grey, and the animals apparently contained less oil.

The investigations will be continued during 1952.

KAARE R. GUNDERSEN.

## THE FISH

### Fish Eggs and Larvae.

#### Along the Coast of Northern Norway during April-June 1950 and 1951.

Investigations incorporating the use of the Clarke-Bumpus plankton sampler of the occurrence of eggs and larvae of fish in the coastal and bank waters off North Norway were started in the spring of 1947 and have been continued each spring thereafter. The technique introduced in 1948 was used during 1950 and 1951. Three samplers were towed simultaneously, working at different depths, usually from 75 to 55 metres, 50—30 m. and 25—5 m. respectively at a towing speed of 2—3 knots. The nets used were made of silk No. 2. Further details of the sampling technique are given in an earlier report (WIBORG 1951).

The figures have been calculated as numbers below one square metre of sea surface. In the drawings a + indicates a negative haul.

#### Cod, *Gadus callarias*.

At the end of April and beginning of May 1950 the majority of the cod eggs spawned in the Lofoten area during the spring had probably been hatched, but there were still some eggs left, numbers usually being below 100 per 1 m.<sup>2</sup>, except in a few places (Fig. 6). In the Vestfjord cod larvae numbered on the average between 0 and 30, in some places as high as 130 per m.<sup>2</sup> (Fig. 7). Outside the Lofoten islands and in the Andfjord the cod larvae were scarce, except in one place, where more than 1600 larvae were found per square metre. North of the Svendsgrunnen there were few or no cod larvae.

It is very obvious that cod larvae were much more scarce in 1950 than in the year before, when several thousand larvae occurred below 1 m.<sup>2</sup> in the Vestfjord, and many cod larvae were also found on the coastal banks north of Lofoten to Söröysund.





Vestfjord, Vesterålen, and Andfjord, 1950.

Figure 6. Number of Cod Eggs, below 1 m.<sup>2</sup> of surface, 3. 8. May.

Figure 7. Number of Cod Larvae per m.<sup>2</sup>, 3.—8. May.Figure 8. Number of Cod Larvae per m.<sup>2</sup>, 31. May—3. June.

NB. In the these and the following figures a indicates a negative haul.

We are able to give further confirmation of this fact. At Skrova in the Vestfjord and at Eggum on the outer side of the Lofoten islands permanent stations have been established where vertical hauls are taken with the Nansen net at regular intervals all the year round. In Table 1 are given the number of cod eggs and larvae taken in the periods 2. February—24. May 1949 and 13. March—22. May 1950. During the spring of 1949 cod eggs and larvae were numerous at the Skrova station, and there were also several at Eggum, while in 1950 cod eggs were scarce in both localities and only single cod larvae were found during April—May.

At the beginning of June 1950 no cod larvae were caught in the outer part of the Vestfjord and only few further in, (Fig. 8) except in the Austnesfjord, a small fjord in the inner part of the Vestfjord, where 67 larvae occurred per square metre. In the Andfjord there were 2—9 larvae per m.<sup>2</sup>, on the Svendsgrunnen one station with 25 larvae per m.<sup>2</sup>, but further north only single larvae.

In 1951 some hauls were made with the C. B.-sampler in the Vestfjord at the beginning of April. Figure 9 shows the number of cod eggs per square metre of sea surface. The eggs are concentrated in two areas, near Skrova in the inner part (maximum 1150 eggs/m.<sup>2</sup>) and around the outermost Lofoten islands (maximum 6000 eggs/m.<sup>2</sup>). In the in-

**Table 1. Number of Cod Eggs and Larvae caught in vertical hauls from bottom to surface with the Nansen net during 1949 and 1950.**

| Date         | Skrova |        | Date         | Eggum |        |
|--------------|--------|--------|--------------|-------|--------|
|              | Eggs   | Larvae |              | Eggs  | Larvae |
| 1949         |        |        | 1949         |       |        |
| 26. Febr.... | 13     | 0      | 26. Febr.... | 0     | 0      |
| 3. March...  | 209    | 0      | 3. March...  | 7     | 0      |
| 19. » ...    | 349    | 0      |              |       |        |
| 9. April...  | 666    | 8      | 8. April...  | 43    | 2      |
| 25. » ...    | 0      | 82     | 23. » ...    | 52    | 12     |
| 30. » ...    | 31     | 68     |              |       |        |
| 2. May...    | 50     | 150    | 2. May...    | 21    | 22     |
| 16. » ....   | 0      | 4      |              |       |        |
| 24. » ....   | 0      | 1      | 21. » ...    | 7     | 3      |
| 1950         |        |        | 1950         |       |        |
| 13. March... | 20     | 0      | 14. March... | 0     | 0      |
| 20. » ...    | 2      | 0      | 31. » ...    | 3     | 0      |
| 11. April... | 67     | 0      | 11. April... | 9     | 0      |
| 15. » ...    | 78     | 1      | 28. » ...    | 22    | 1      |
| 25. » ...    | 32     | 1      | 8. May...    | 19    | 0      |
| 2. May...    | 13     | 1      | 22. » ...    | 2     | 1      |
| 6. » ...     | 21     | 3      |              |       |        |
| 16. » ...    | 1      | 0      |              |       |        |

ner part of the fjord the eggs were mostly newly spawned, while in the outer part there were more eggs in the later stages of development. Between these two areas the number of cod eggs scarcely exceeded a hundred per square metre. In April 1949, the cod eggs were much more numerous, in most parts of the Vestfjord exceeding 5000 per m.<sup>2</sup>.

During a cruise with the "G. O. Sars" at the beginning of April 1951 on the banks



Figure 9. Number of Cod Eggs per m.<sup>2</sup> in the Vestfjord 4.—5. April 1951. In italics: Number of cod eggs per 10 minutes surface haul with the one-metre egg-net on the banks from Röst to Malangsrunden 3.—11. April 1951.

Cross-hatched 6000—10000 eggs per m.<sup>2</sup>

Single-hatched 1000—100 » » »

Outside the Vestfjord the hatching has been made subjectively (see text).

outside Lofoten some horizontal hauls were made at the surface with a one-metre egg-net. In Figure 9 the figures in italics indicate the

number of cod eggs taken per 10-minute haul with the egg-net. These hauls cannot be compared directly with the C.B.-hauls, as we do not know exactly the volume of water filtered, and the net was only working at the surface. According to previous observations one may get an idea of the numbers per square metre sea surface by dividing the figures by 10. Cod eggs were numerous just outside the Lofoten islands and there were also some on the banks from Röst to Vesterålen, but few or none outside the shelf. Compared with the numbers of cod eggs in the Vestfjord, the numbers on the banks outside were on an average low.

In the open sea NW. of the Andfjord a number of newly spawned eggs were found; they may have been brought out by currents; there is the possibility that they were eggs of haddock. — Near Eggum and Röst 60—70 % of the eggs were in an early stage of development, while at the other stations on the bank most of the eggs had reached later stages. They had probably been spawned a fortnight ago, and been drifting with the currents since then.

The Vestfjord was investigated for a second time in 1951 at the beginning of May. In the central and inner part of the fjord there were still some cod eggs, especially on the banks along the Lofoten islands (Fig. 10). At the beginning of May 1948 the number of cod eggs was about the same as at the beginning

Stars: > 500 larvae per m.<sup>2</sup>  
Cross-hatched: 500—100 per m.<sup>2</sup>  
Single-hatched: 100—10 per m.<sup>2</sup>



Figure 10. Number of Cod Eggs per m.<sup>2</sup>, 30. April—10. May.



Vestfjord, Vesterålen, and Andfjord, 1951.  
Figure 11. Number of Cod Larvae per m.<sup>2</sup>, 30. April—10. May.

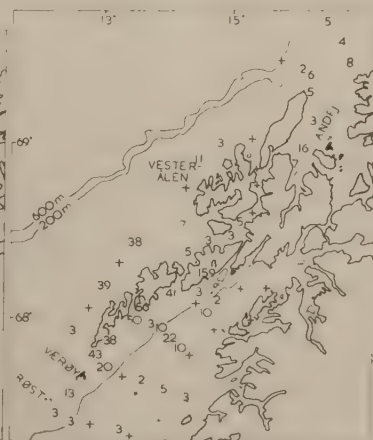


Figure 12. Number of Cod Larvae per m.<sup>2</sup>, 22—30. May.

of May 1951, in 1949 somewhat higher and in 1950 a little lower. The hatching of the cod eggs must have been going on for some time, as we found a number of cod larvae (Fig. 11). Most of the larvae were concentrated in the inner part of the Vestfjord, and they were scarce in the outer part of the fjord. This is in accordance with previous observations. Owing to the coastal current which goes NW.-wards across the fjord, the larvae will be kept away from the southern part of the fjord (see WIBORG 1950). Several cod larvae occurred in the innermost part of the Andfjord and of the Eidsfjord, but they were scarce on the banks outside the Lofoten islands and Vesterålen. As regards the Vestfjord it is doubtful whether a great number of cod eggs and larvae drift away from the fjord. The distribution of eggs at the beginning of April might indicate a certain concentration of eggs in the area around the outermost islands and along the shore outside the Lofoten islands. As spawning usually takes place on all these banks, nothing can be said with certainty as to the drifting of eggs and larvae. At the beginning of May the number of cod larvae decreases very suddenly as we pass from the mouth of the fjord and on the outer banks northwards. The large number of cod larvae in the Hadsel-fjord may originate from eggs which were located just outside the Lofoten islands (Fig. 9), or from a local spawning. Very few cod larvae were caught in the middle of May in the area from the Fugløybank to Sörøysund.

The last series of observations was taken at the end of May. Single cod larvae then occurred on the banks from the Sörøya and southwards, but few were found in the Hadsel-fjord, Andfjord and outside the Vesterålen. In some places outside the Lofoten islands the larvae were more numerous and numbered up to 38 per square metre. In the Vestfjord there were on the whole few larvae, but along the shores "Lofotveggen" the numbers were higher, reaching 55 larvae per square metre, and in the small Austnesfjord as many as 159 larvae per square metre were recorded. It would seem that the larger cod larvae approach the shores. Similar observations were made long ago by G. O. SÆRS (1878). The larvae possibly gather in schools. But currents might also be responsible for a shoreward concentration of eggs and larvae. Figures on the occurrence of cod eggs and larvae are also available from the permanent stations in Lofoten during 1951 (Table 2).

At Skrova cod eggs were more numerous in 1951 than in the previous year, but more scarce than in 1949. Cod larvae occurred in scanty numbers from 17. April to 5. May. At Eggum on the ocean side of the Lofoten islands the number of cod eggs exceeded that in 1949; the larvae were as numerous, and present from the middle of March to the beginning of May.

#### Vertical distribution of cod eggs and larvae.

As in previous years cod eggs and larvae occurred in the upper 50 metres only, with the bulk concentrated in the upper 25 metres. At the beginning of May 1951 the average ratios of the numbers of eggs and larvae in the 25—5-metre hauls to the numbers in the 50—30-metre hauls in the Vestfjord were 4 to 1 for the larvae and 6 to 1 for the eggs. On odd occasions, as at some stations near the outermost islands, eggs and larvae were more numerous in the deeper hauls.

#### Eggs and larvae of other species of fish.

**Haddock.** *Gadus aeglefinus*. No larvae, and only single eggs of haddock were found during the investigations in 1950 and 1951. The newly spawned eggs taken in the open sea outside the Andfjord (Fig. 9) in April might however, have been eggs of haddock. The year 1948 must have been an exception, as a number of haddock larvae were then taken on the banks from the Andfjord and northwards (WIBORG 1950). There is the possibility that either the spawning of haddock in these areas is usually of very little importance, or the spawning must take place later in the season, in May-June. Spawning areas of haddock may also be found on the Helgeland banks further south. These banks were investigated at the end of April 1951 during a cruise of the

**Table 2. Number of Cod Eggs and Larvae caught in vertical hauls from bottom to surface with the Nansen net during 1951.**

| Skrova      |      |        | Eggum       |      |        |
|-------------|------|--------|-------------|------|--------|
| Date        | Eggs | Larvae | Date        | Eggs | Larvae |
| 1951        |      |        | 1951        |      |        |
| 19. March.. | 0    | 0      | 13. March.. | 6    | 3      |
| 27. » ..    | 34   | 0      |             |      |        |
| 31. » ..    | 5    | 0      | 31. » ..    | 85   | 2      |
| 7. April... | 54   | 0      | 11. April.. | 303  | 10     |
| 17. » ...   | 260  | 3      |             |      |        |
| 28. » ...   | 35   | 9      | 26. » ..    | 144  | 14     |
| 5. May....  | 11   | 7      | 8. May...   | 5    | 2      |
| 21. ....    | 0    | 0      | 23. » ...   | 0    | 1      |
| 26. ....    | 1    | 0      |             |      |        |





Vestfjord, Vesterålen, and Andfjord.

Figure 13. Occurrence of Herring Larvae, 30. April—10. May, and (in circles) 22.—30. May 1951.

Figure 14. Number of Redfish Larvae per m.<sup>2</sup>, 3.—8. May, and (in circles) 31. May—9. June 1950. The underlined stations were taken only during 3.—8. May.

Figure 15. Number of Redfish Larvae per m.<sup>2</sup>, 30. April—10. May, and (in circles) 22.—30. May 1951. The underlined stations were taken only during the period 30. April—10. May.

All stations were taken twice, a single figure indicating that no records were made during the other period.

“G. O. Sars”, but only few eggs were found at the outskirts of the Trena bank.

Russian investigators (ALEJEV 1944) found several eggs and larvae of haddock on the banks from Vesterålen and northwards during April-June 1934 and 1935.

**Herring.** *Clupea harengus*. At the beginning of May 1950 only very few larvae of herring were found in the mouth of the Vestfjord and on the banks northwards to Malangsgrunnen. No larvae were taken during the cruises in April 1951, but at the beginning of May some were found in the outermost part of the Vestfjord and on the banks outside, as shown in Figure 13. Usually there were only 4—5 larvae below 1 m.<sup>2</sup>, with the exception of single stations in the outer Vestfjord, in the Andfjord, and on the edge of the bank (underlined letters) where respectively 32, 20 and 7 larvae were taken. Herring larvae also occurred in the said localities and at some stations in the inner Vestfjord at the end of May 1951. The conditions were in good agreement with those found in 1948—49.

**Redfish.** *Sebastes marinus*. The number of redfish larvae taken between Lofoten and the Andfjord during 1950 is shown in Figure 14. The larvae occurred sparsely and scattered at the beginning of May, but one month later

numbers were somewhat greater, up to 61 larvae per square metre of sea surface. Some larvae were also found on the banks northwards to Nordkapp. In 1951 (Fig. 15) redfish larvae were more scarce than in 1950. The spawning may have been delayed because of the lower temperature. Normally the redfish spawns in these waters at the end of May.

**Capelin.** *Mallotus villosus*. The main spawning area of the capelin is situated along the coast of Finmark and eastwards to the Rybachi

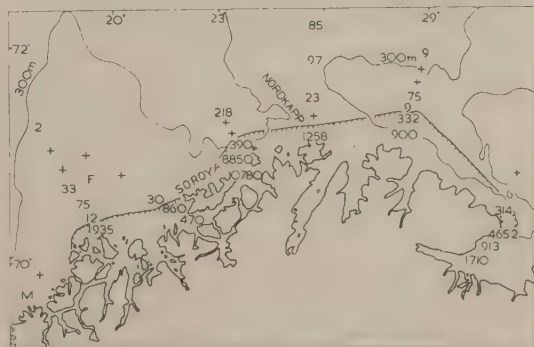


Figure 16. Number of Capelin Larvae per m.<sup>2</sup> from the Fuglöybank to the Varangerfjord, 16.—31. May 1950. The spawning area is indicated.



Figure 17. Number of Capelin Larvae per m.<sup>2</sup> from the Malangsgrunnen (M) to North Cape, 18.—23. May 1951. The spawning area is indicated.

peninsula. In recent years spawning has also taken place further south. In 1948 the southern limit was at Söröya but in 1949 and 1950 the spawning area extended southwards to the Fuglöybank.

In Figure 16 is shown the number of capelin larvae per m.<sup>2</sup> from the Fuglöybank to the Varangerfjord in May 1950. Near the shore the numbers of larvae were usually very high, in one locality exceeding 10,000 per square metre, but decreased very sharply with increasing distance from the shore.

In 1951 the conditions were quite exceptional. During the early spring shoals of capelin were met with even as far south as in the Vesterålen and outside the Lofoten islands, and during the first days of May some larvae of capelin occurred in the plankton samples from the outer Andfjord. Further north the larvae were very numerous and distributed from Malangsgrunnen to North Cape (Fig. 17). The investigations did not extend further east, but it is supposed that spawning had taken place all along the coast of Finnmark.

In the last half of May a number of capelin larvae were met with from the Vesterålen banks to the mouth of the Vestfjord (Fig. 18). The figures were much lower than further north, but still high—in the Andfjord 1614 larvae and in the outer Vestfjord 42 larvae per m.<sup>2</sup>.

The southward extension of the spawning area of the capelin may be due to the lower sea temperature in the early spring. According to the information given by Dr. Eggvin at the hydrographical section of the Institute, the temperature in the upper 50 metres of the



Figure 18. Number of Capelin Larvae per m.<sup>2</sup> in the Vestfjord, Vesterålen and the Andfjord 23.—30. May 1951.

sea at Eggum was between 4.5 and 5.5 degrees C. during March-April 1950, while at the same time in 1951 the temperature was approximately 1 degree lower, between 3.5 and 4.5 degrees C.

Eggs and larvae of plaice, torsk, Ammodytes and other species of fish also occurred in the plankton samples, but they were all scarce in relation to those mentioned above.

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#### Literature.

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#### Cod.

##### Recaptures in the Barents Sea of Cod tagged in Norwegian Waters.

Since 1946 we have annually carried out tagging experiments on 'skrei', that is the mature fish belonging to the Arcto-Norwegian stock of cod. In 1946 the experiments were made on the coastal banks in the Tromsø district, in 1947 and later years exclusively on the Lofoten banks. Through these investigations we intend to get a better knowledge about the migrations of the 'skrei'. We also wish

to get an idea as to the intensity of fishing on the same population. In the following the geographical distribution of the recaptures from the Barents Sea during the years 1946—49 will briefly be shown.

Generally the experiments have been carried out during the main fishing season. Most of the work in Lofoten has thus been done in the period February-March. Some of the fish, therefore, have been recaptured within the Lofoten district during the same season. Generally, however, the "skrei" disappears from these waters during the month of April. Just after the middle of April several specimens are retaken in the coastal waters to the north of Lofoten. The fish migrate, therefore, northwards after spawning. A more detailed study has shown that the fish may wander at a rather high speed, sometimes at an average of about 30 km. a day.—The cod disappears very quickly from the Norwegian waters. After the end of May, fish which have been tagged on the Lofoten banks are only rarely caught in our waters before next winter.

During summer we regularly get a number of recaptures from the Barents Sea, see Figure 19. Their distribution as to locality and time of capture seems to indicate that some of the fish, having left the coastal waters, migrate directly to the Bear Island banks. The fish which have been recaptured on these grounds have all been taken during the period 21. May—22. June.

Another group of the "skrei" evidently takes a more easterly course. Thus many of the tagged fish have been recaptured on the banks to the north of the Russian coast, especially during the period 25. May—21. July. A few fish have also been taken in November and December.



Figure 19.

It will appear that most of the recaptures from the Bear Island banks and from the south-eastern parts of the Barents Sea have been made within short periods of time. It seems as if the fish also pass by these banks on their feeding migration. Only as a rare exception have fish been recaptured here in the period August-October. During that season we have got a few recaptures from the waters to the east of the Hopen Island. Some of the "skrei", therefore, migrate to those distant grounds when feeding. We have not material, however, to show if this is the habit of the main body of the mature fish within this population. It is to be hoped that the future investigations of the nations now working in these areas may throw more light on these problems.

GUNNAR DANNEVIG.



# North-Western Area.

## INTRODUCTION

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During the year research vessels from Denmark, Iceland, Norway and Scotland have operated fairly regularly in the area; besides, observations from other vessels have been obtained (see the Administrative Report, Rapp. et Proc.-Verb., Vol. No. 134).

### Environment.

The hydrographical data cover all the most important sub-areas.

The main information from 1951 lies on the same lines as in the preceding year, viz., 1) the monthly anomalies of the surface temperatures 2) the main hydrography in the important herring area north of the Faroes, 3) the hydrography off North Iceland, 4) the hydrography of the cod fishing banks off West Greenland, and 5) general information on the climatic changes in the sea.

Of great importance to the fishery is the information on the East Icelandic polar current and its rôle for the feeding and spawning migrations of the Atlanto-Scandian herring; much remains still to be investigated, but the information already obtained is very promising. It seems that the feeding herring accumulate especially in the mixed water along the border-lines of the arctic current, and that the rate of migration towards the spawning areas is of approximately the same magnitude as the rate of the east-going current.

The conditions in the sea north of Iceland were similar to those in 1949 and 1950, but the ice-condition, especially in August, was abnormal, because the ice was plentiful and near to the north-west coast of Iceland.

The relation of the cod fishery to temperature on the western slope of the fishing banks in the Davis Strait was followed also in 1951; the slack period in the fishery observed in 1949, 1950 and 1951 at mid-summer time seems to be correlated with a drop in temperature caused by a more intensive polar current; cod fishing is not profitable at a bottom temperature below 2° C.

The study of the monthly anomalies of the surface temperature was continued; the temperatures were still high, but indicated a certain instability in some of the sub-areas of the North Atlantic as also at Myggenæs in the Faroes.

The plankton researches carried out by the Scottish research vessels are being continued and the plankton distribution can be linked with the water movements; the changes are correlated with flows of water of polar, boreal, Biscayan and of open north-east Atlantic origin.

### The Fish.

Herring investigations are reported on elsewhere in this volume (p. 136—40).

Cod. The spawning of cod at the Faroes was early in 1951 and the strength of the year-class probably normal. From Iceland and Greenland no records are available. From West Greenland, however, some supplementary observations to those obtained by the "Dana" in 1950 are given.

The age-assessment from Iceland shows that the 1942 year-class was dominating on the spawning grounds in 1951, and recent studies have further shown that the examination of the spawning zones in the cod otoliths has permitted us to make one year earlier than before rather accurate qualitative and quantitative predictions of the spawning stock.

In Greenland waters researches from 1950 and 1951 show the 1934, 1936, 1942, 1945, and 1947 year-classes predominant both in inshore waters and on the offshore banks. The 1947 year-class seems to be very rich. The growth is slow, but the size distribution and general migrations as indicated by marking experiments resemble those of recent years.

**Haddock.** In the Faroe area the production of fry seems still to be higher than in pre-war years. The stock (commercial landings) is composed of about 12 year-classes, but the numbers per 10 hours fishing of the 1950 and 1949 broods were considerably lower during 1951 than the landings of the 1949 and 1948 broods during 1950. The average commercial trawler landings in 1951 (ca. 126 cwts.) are much lower than in the preceding years, but still higher than in 1939 (ca. 96 cwts.). The mortality rate has been calculated to 68% annually.

**Saithe.** An interesting report shows that during some years a single year-class of saithe, i. e., that of 1945, was of great importance to the fishery off North Iceland. In 1950 it constituted 97% of the total saithe yield, in 1951 75.8%.

**Lemon Sole.** The steady rise of the British trawling efforts in Faroe waters (in 1951 for the first time since 1937 exceeding 200,000 trawling hours) has caused the average catch per 100

hours fishing to fall from 33 cwts. in 1946 to 15 cwts. in 1951. Failure of some younger year-classes will probably make the situation still worse during the next years.

**Halibut.** The most valuable information on this fish comes from Denmark Strait and regards the fishery in 1950. In the material of about 780 fish, size 70–200 cm., the 11–15-year olds dominated. The 1938 and 1939 year-classes were outstanding, which is in accordance with researches carried out in Faxe Bay just before the war.

**Redfish.** The stock on the important redfish grounds off West Iceland seems to decrease, both in catch per unit of effort as in size of fish caught. It is very important that studies on migration of adults, dispersion of fry, recruitment of stock etc. are carried out on this fish the contribution of which to the yield of the fishery in the North Atlantic has become of prime importance.

Å. VEDEL TÅNING.

## ENVIRONMENT

### Hydrography.

#### Monthly Anomalies of the Surface Temperature in Areas of the northern North Atlantic in 1951.

As usual, the 1951 issue of the Danish Nautical-Meteorological Annual contains temperature means for each month and each 1°-rectangle in most parts of the northern North Atlantic. These means have been compared with the grand monthly means for the period 1876–1915, published by RYDER<sup>1)</sup>. The anomalies found in this way were then averaged over the areas indicated in Figure 1.

The results are given in Table 1 where monthly anomalies are recorded together with the numbers of observations on which they are based. It will be seen from the table that positive anomalies are still predominant in most areas. However, in a group of areas (D,

F, and M) to the south-west of Iceland, negative anomalies predominated during the year considered. The same applies to Area N where negative anomalies also predominated in the



Figure 1. Location of areas and stations.

<sup>1)</sup> RYDER 1917. Monthly Mean Temperatures of the Surface Water in the Atlantic, North of 50°N. Lat. (App. to Naut.-Meteor. Annual). Copenhagen.

Table 1. Monthly Anomalies ( $^{\circ}$  C.) and Numbers (n) of Observations of the Surface Temperature in the Areas A-N (see Figure 1) during 1951.

| Area   | Jan.<br>$\Delta$ n | Feb.<br>$\Delta$ n | March<br>$\Delta$ n | April<br>$\Delta$ n | May<br>$\Delta$ n | June<br>$\Delta$ n | July<br>$\Delta$ n | August<br>$\Delta$ n | Sept.<br>$\Delta$ n | Oct.<br>$\Delta$ n | Nov.<br>$\Delta$ n | Dec.<br>$\Delta$ n |
|--------|--------------------|--------------------|---------------------|---------------------|-------------------|--------------------|--------------------|----------------------|---------------------|--------------------|--------------------|--------------------|
| A..... | — —                | — —                | -1.5 3              | 0.2 13              | 0.6 73            | 0.7 112            | 0.3 187            | 0.5 63               | 1.4 97              | 0.8 66             | 0.4 16             | — —                |
| B..... | — —                | — —                | -1.6 48             | 0.0 74              | 0.6 186           | 0.8 113            | 1.1 87             | 0.4 90               | 0.5 68              | 0.5 99             | -0.1 50            | 0.4 9              |
| C..... | — —                | — —                | -0.3 19             | -0.2 21             | 0.4 52            | 0.8 57             | 0.8 51             | 0.8 72               | 0.3 34              | -0.1 39            | 0.9 7              | — —                |
| D..... | 0.8 9              | -1.9 1             | -0.4 41             | -0.2 34             | 0.3 66            | 0.5 70             | 0.5 31             | 0.3 43               | -0.7 30             | -0.3 19            | -0.4 18            | -0.3 13            |
| E..... | 0.9 70             | 0.4 6              | 0.5 33              | 0.6 16              | 0.8 44            | 1.4 35             | 1.0 30             | 0.9 31               | -0.8 24             | 0.7 55             | 0.4 62             | -0.4 65            |
| F..... | — —                | 0.1 3              | -0.8 37             | -0.6 49             | -0.1 99           | 0.8 83             | 0.4 52             | 0.3 69               | -0.1 46             | -0.4 23            | -0.2 32            | -0.6 27            |
| G..... | -0.3 5             | 0.7 8              | -0.5 8              | -1.0 11             | 0.2 6             | 1.0 8              | -0.1 16            | 0.5 21               | 0.5 6               | 0.8 13             | 0.4 14             | 0.1 10             |
| H..... | 0.4 21             | 0.4 43             | -0.3 90             | -0.4 70             | 0.0 120           | 0.9 116            | 0.7 79             | 0.8 109              | 0.6 111             | 0.6 42             | 0.2 117            | -0.1 46            |
| I..... | 0.8 4              | 0.8 9              | 0.2 11              | -0.8 4              | -0.2 7            | 1.0 14             | 1.3 26             | 1.2 8                | 1.2 17              | 1.6 10             | 0.8 5              | 0.6 5              |
| J..... | 0.5 21             | 0.5 27             | 0.2 45              | -0.6 35             | -0.2 48           | -0.2 136           | 0.2 56             | 0.5 56               | 0.6 76              | 1.4 30             | 1.0 63             | 0.7 49             |
| K..... | 0.4 19             | -0.1 22            | -0.4 44             | -0.9 47             | -0.8 54           | 0.0 51             | -0.1 35            | 0.0 46               | 0.4 40              | 1.1 37             | 1.0 54             | 0.6 42             |
| L..... | 0.5 29             | 0.5 7              | -0.3 47             | -0.8 40             | -0.1 36           | 0.6 37             | 0.6 20             | 0.9 31               | 0.2 25              | 0.8 29             | 0.4 45             | -0.3 55            |
| M..... | 0.1 36             | -0.6 8             | -1.0 49             | -0.8 49             | 0.3 45            | 0.4 41             | 0.7 14             | 0.5 31               | -0.2 35             | 0.6 30             | -0.4 45            | -1.0 46            |
| N..... | 1.5 1              | — —                | -0.6 6              | -1.5 4              | -0.3 4            | — —                | — —                | — —                  | — —                 | -0.1 4             | -0.8 12            | — —                |

immediately foregoing years. On the other hand, positive anomalies now predominate in Area E, in contrast to conditions there in the other post-war years.

JENS SMED.

#### Hydrographic Conditions in the Minch. September/October 1951<sup>1)</sup>.

A hydrographic survey of the north Minch was carried out in September of last year and a similar survey of the south Minch in October. The temperature and salinity observations are presented in Figure 2.

In the case of salinity there is agreement at corresponding points between the two surveys, and consequently the two surveys have been presented on single charts. There would not appear to be any justification for doing this with the temperature observations.

From these data we may give the following description of conditions at the time.

Central Minch: A vertically and horizontally homogeneous area of highly diluted water.

N.-E. Minch: An outflow to the north of central Minch water.

N.-W. Minch: Occupied by water from west of the Hebrides spreading round the Butt

of Lewis shelf. Note: This is not oceanic water but typical continental shelf water. S.-Minch: Inflow of oceanic water near bottom and of continental shelf water in the upper layers. There is a narrow belt of highly diluted water close against the east shore.

R. E. CRAIG.

#### Variation of the Temperature of the Surface Water at Station Myggenæs (Faroes) during the Years 1914—51.

From 1914 onwards the Danish Meteorological Office has arranged for daily observations of the temperature of the surface water, at Myggenæs light ( $62^{\circ}06'N.$ ,  $7^{\circ}40'W.$ ) on the westernmost point of the Faroe Islands. The observations are carried out at 0800 G.M.T. The daily temperature values together with monthly means have been printed in the publications of the Meteorological Office — for the years 1914—19 in the relevant issues of *Annuaire Météorologique* II; for the period 1920—49 in *Annuaire Météorologique*, Addendum à la 1ère partie: "Îles Féroé, 1940—1945 et Supplément", published 1951, and from 1949 onwards in *Annuaire Météorologique* I. Thus observations from a long series of years are now available, and it is of interest to examine this material with a view to studying the variations of the temperature from year to year.

<sup>1)</sup> The more extensive surveys carried out by Scotland in this area, mainly in the Faroe-Shetland Channel, are described as usual in association with the related North Sea surveys (North Sea, p. 94, by J. B. TAIT).

Table 2. Grand Monthly Means of the Surface Temperature ( $^{\circ}$  C.) at Myggenæs during the Period 1914—50.

| Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|------|------|-------|-------|-----|------|------|------|-------|------|------|------|
| 6.3  | 6.0  | 5.9   | 6.3   | 7.1 | 8.2  | 9.3  | 9.8  | 9.7   | 9.1  | 7.9  | 7.0  |



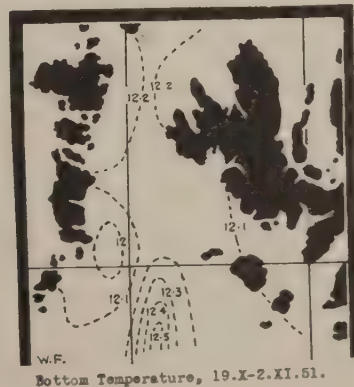
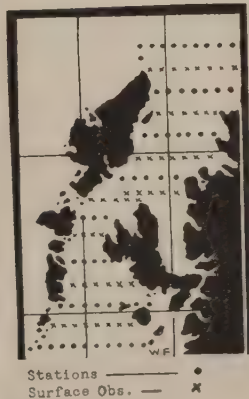
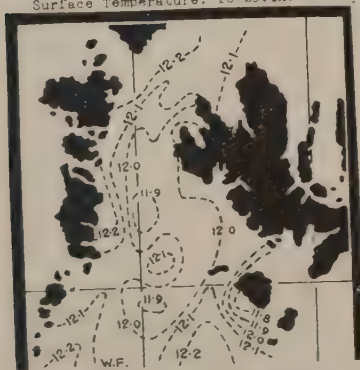
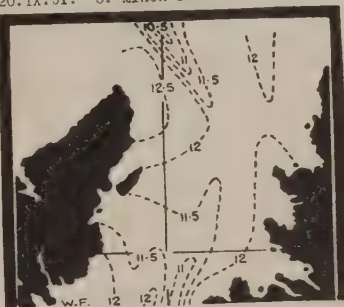
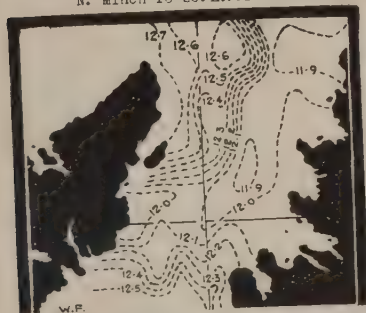


Figure 2. Hydrographic conditions in the Minch, September/October, 1951.

Table 3. Monthly Anomalies of the Surface Temperature ( $^{\circ}\text{C}$ ) at Myggenæs during 1914—51.

|           | Jan. | Febr. | March | April | May  | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Average |
|-----------|------|-------|-------|-------|------|------|------|------|-------|------|------|------|---------|
| 1914..... | 0.1  | 0.0   | -0.2  | -0.1  | -0.5 | -0.2 | -0.3 | -0.2 | -0.1  | 0.1  | -0.1 | -0.6 | -0.2    |
| 15.....   | -0.2 | -0.3  | -0.6  | -0.6  | -0.8 | -0.4 | -0.7 | -0.5 | -0.5  | -0.2 | -0.3 | -1.1 | -0.5    |
| 16.....   | -0.3 | -0.4  | -0.7  | -0.3  | 0.0  | 0.1  | -0.1 | 0.2  | 0.5   | -0.2 | 0.1  | -0.4 | -0.1    |
| 17.....   | -0.4 | -0.4  | -0.3  | -1.3  | -0.8 | -0.5 | -0.5 | -0.2 | -0.2  | -0.9 | -0.9 | -1.6 | -0.7    |
| 18.....   | -2.0 | -0.7  | -0.4  | -0.3  | 0.1  | -0.2 | -0.1 | 0.0  | -0.6  | -0.6 | -0.1 | 0.0  | -0.4    |
| 19.....   | -0.3 | -0.5  | -0.9  | -0.9  | -0.4 | 0.0  | -0.2 | -0.2 | -0.3  | 0.7  | -1.1 | -0.9 | -0.5    |
| 20.....   | -0.9 | -0.7  | -0.6  | -0.6  | -0.6 | -0.4 | -0.6 | -0.5 | -0.3  | 0.2  | 0.7  | 0.9  | -0.3    |
| 21.....   | 0.4  | 0.2   | 0.0   | 0.1   | -0.2 | -0.4 | -0.4 | -0.5 | -0.5  | -0.3 | -0.2 | 0.1  | -0.1    |
| 22.....   | -0.3 | 0.1   | 0.1   | -0.3  | -0.5 | -0.5 | -0.8 | -0.6 | -0.6  | -0.4 | -0.3 | -0.1 | -0.4    |
| 23.....   | 0.0  | 0.1   | 0.4   | 0.4   | -0.3 | -0.6 | -0.6 | -0.4 | -0.5  | -0.7 | -0.7 | -1.0 | -0.3    |
| 24.....   | -0.4 | -0.3  | -0.6  | -0.6  | -0.7 | -0.8 | -0.9 | -0.4 | -0.3  | -0.2 | 0.2  | 0.5  | -0.1    |
| 25.....   | 0.5  | -0.3  | -0.2  | -0.4  | -0.1 | 0.0  | 0.0  | 0.1  | -0.1  | -0.2 | 0.0  | -0.8 | -0.1    |
| 26.....   | -0.1 | 0.3   | 0.3   | 0.5   | 0.3  | 0.2  | 0.1  | 0.4  | 0.1   | -0.4 | -0.2 | -0.6 | 0.1     |
| 27.....   | -0.5 | 0.0   | 0.4   | -0.1  | -0.5 | -0.8 | -0.6 | -0.3 | -0.6  | -0.6 | -0.5 | 0.4  | -0.4    |
| 28.....   | -0.3 | -0.2  | 0.2   | 0.2   | 0.2  | -0.3 | 0.4  | -0.5 | -0.2  | -0.1 | 0.0  | 0.0  | -0.1    |
| 29.....   | 0.0  | 0.3   | 0.9   | 0.6   | 0.3  | 0.1  | -0.1 | -0.3 | 0.6   | -0.6 | -0.8 | 0.0  | 0.0     |
| 30.....   | -0.2 | 0.1   | -0.5  | 0.0   | 0.2  | 0.6  | 0.2  | 0.4  | 0.5   | 0.1  | -0.2 | -0.2 | 0.1     |
| 31.....   | -0.4 | -0.9  | -1.0  | -0.6  | -0.3 | -0.7 | 0.0  | -0.3 | -0.4  | -0.2 | 0.3  | 0.2  | -0.4    |
| 32.....   | 0.0  | 0.4   | 0.3   | -0.3  | -0.5 | -0.2 | 0.0  | 0.0  | -0.3  | -0.6 | -0.1 | 0.0  | -0.1    |
| 33.....   | 0.4  | -0.6  | 0.1   | -0.2  | 0.2  | 0.8  | 0.8  | 0.6  | 0.5   | 0.5  | 0.6  | 1.0  | 0.4     |
| 34.....   | 0.6  | 0.4   | 0.0   | -0.3  | -0.3 | 0.0  | 0.0  | 0.1  | 0.4   | 0.0  | -0.3 | 0.3  | 0.1     |
| 35.....   | 0.7  | -0.6  | 0.2   | -0.2  | 0.2  | 0.0  | 0.1  | 0.3  | 0.2   | -0.1 | 0.2  | -0.2 | 0.1     |
| 36.....   | -0.6 | -0.3  | -0.1  | -0.4  | 0.6  | 0.4  | 0.4  | 0.5  | 0.6   | 0.4  | 0.4  | -0.3 | 0.1     |
| 37.....   | 0.1  | -0.1  | -0.9  | -0.1  | 0.2  | -0.1 | 0.2  | 0.3  | 0.4   | 0.3  | 0.1  | 0.2  | 0.0     |
| 38.....   | 0.4  | -0.1  | 0.6   | 0.4   | 0.2  | 0.2  | -0.1 | -0.2 | 0.3   | 0.4  | 0.6  | 0.8  | 0.3     |
| 39.....   | 0.1  | 0.5   | 0.6   | 0.5   | 0.6  | 0.3  | 0.3  | 0.5  | 0.8   | 0.6  | 0.7  | 0.7  | 0.5     |
| 40.....   | 0.6  | 0.8   | 0.3   | 0.1   | 0.5  | 0.6  | 0.4  | 0.5  | 0.2   | —    | —    | —    | 0.4     |
| 41.....   | —    | -0.2  | 0.2   | 0.1   | 0.2  | 0.2  | 0.3  | 0.2  | 0.7   | 1.0  | 0.8  | 0.1  | 0.3     |
| 42.....   | 0.4  | 0.3   | 0.4   | 0.3   | 0.5  | 0.1  | 0.0  | -0.1 | 0.1   | -0.1 | 0.3  | -0.2 | 0.2     |
| 43.....   | 0.0  | 0.8   | 0.7   | 0.5   | 0.0  | 0.0  | 0.7  | 0.3  | 0.3   | 0.7  | 0.5  | -0.2 | 0.4     |
| 44.....   | 0.0  | 0.6   | 0.6   | 0.3   | 0.3  | 0.4  | 0.6  | 0.7  | 0.3   | -0.1 | 0.5  | 0.4  | 0.4     |
| 45.....   | -0.1 | -0.1  | 0.2   | 0.4   | 0.4  | 0.3  | 0.2  | 0.4  | 0.7   | 0.5  | 0.6  | 0.9  | 0.4     |
| 46.....   | 1.0  | 0.2   | 0.4   | 0.7   | 0.6  | 0.6  | 0.4  | 0.6  | 0.6   | 0.9  | 0.6  | 0.9  | 0.6     |
| 47.....   | 1.0  | 0.5   | 0.1   | 0.1   | 0.5  | 0.1  | 0.3  | 0.5  | 0.6   | 0.8  | 0.9  | 0.5  | 0.5     |
| 48.....   | -0.1 | 0.4   | 0.9   | 0.7   | 0.3  | 0.0  | 0.0  | 0.2  | 0.3   | 0.1  | 0.0  | 0.4  | 0.3     |
| 49.....   | 0.1  | 0.3   | 0.1   | 0.2   | -0.2 | -0.2 | -0.6 | -0.2 | -0.7  | -1.5 | -1.3 | —    | -0.4    |
| 50.....   | —    | —     | —     | —     | 0.9  | 0.9  | 0.6  | 0.4  | 0.4   | 0.4  | 0.3  | -0.3 | 0.4     |
| 51.....   | 0.2  | 0.1   | 0.2   | -0.2  | -0.4 | -0.6 | -0.7 | -0.5 | -0.1  | 0.6  | 0.7  | 0.3  | 0.0     |

Table 2 gives the grand monthly means of the surface temperature during the period 1914—50. In this connection it should be mentioned that no data exist from the months October 1940—January 1941 and December 1949—April 1950.

The monthly anomalies given in Table 3 were calculated using these grand monthly means as a basis. It is seen that positive anomalies are very predominating from 1933. This feature becomes especially conspicuous when the anomalies are averaged for each year. These averages are plotted in Figure 3. The year 1949, in which negative values predominate, is an exception to the preponderance

of positive anomalies in the later part of the period considered.

JENS SMED.

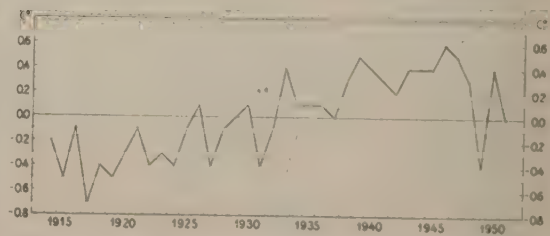


Figure 3. Yearly averages of the monthly anomalies of surface temperature at Myggenæs (Faroes), the period 1914—50 being taken as standard.

# Hydrographic Conditions in the South-Western Part of the Norwegian Sea, 1951.

As in the years 1948 and 1950, extensive hydrographic observations were carried out in 1951 in the area north of the Faroe Islands and between the Shetlands and the Faroes. The investigations were made from R/V "Dana" under the leadership of Å. VEDEL TÅNING in June, and of E. BERTELSEN in November-December.

The distribution of temperature and salinity is shown in Figs. 5, 6 and 7. For the summer cruise it is given for the depths 0, 20 and 100 metres, but for the winter cruise for the depths 0 and 100 metres only as the water at this time was nearly homogeneous in the upper 20 metres. The hydrographic conditions are further illustrated by the sections in Figs. 8, 9, 10 and 11, the locations of which are shown on Figure 4.

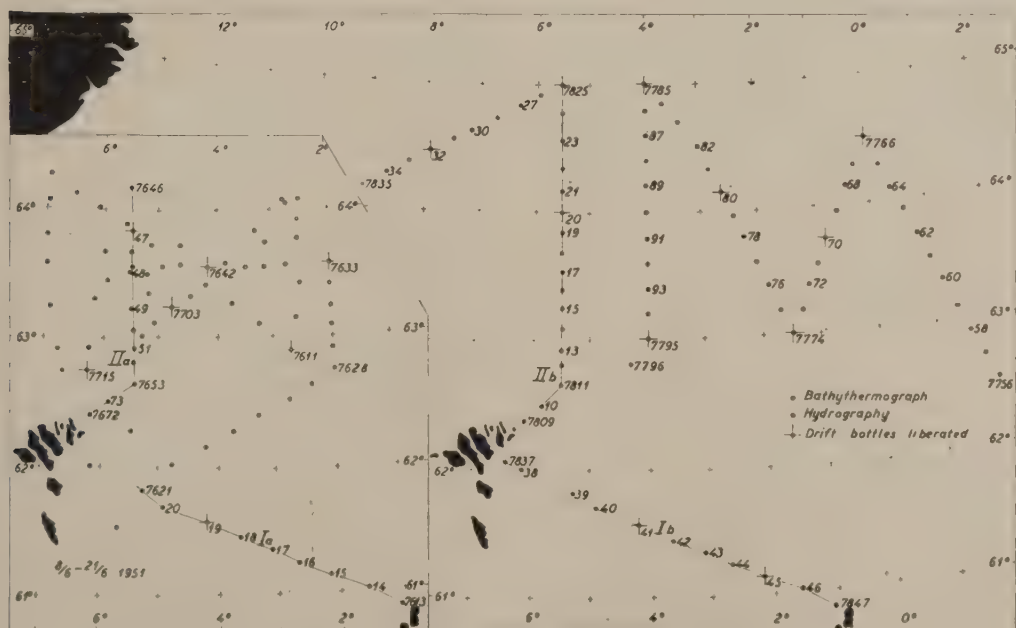
As usual the boundary between the warm Atlantic water and the cold water from the East Icelandic current followed a very complicated course with tongues of cold water stretching deep into the warm water masses.

In June 1951 the cold water extended considerably farther to the east than it did in June 1950 and a tongue of the cold water was stretching southwards to the north-western part of the Faroe-Shetland Channel. In the Faroe-Shetland section only small amounts of warm water were present in June and the inflow into the Norwegian Sea seems to have been small.

In November-December it was found that a strong inflow of warm Atlantic water had taken place and in the easternmost part of the area below 20 metres the temperatures were higher than those found in June. In 100 metres all over the area the temperatures were considerably higher than the June temperatures. The tongue of cold water north-east of the Faroe Islands was at this time divided into two parts by a tongue of warm and saline water.

A comparison with the temperature conditions found by "G. O. Sars" in December 1950<sup>1)</sup> shows that the surface water in this area at the time 19. Nov.—13. Dec. 1951 was 1° to 2° warmer than in December 1950.

The Faroe-Shetland section Figure 9 shows that a very strong inflow of warm Atlantic water





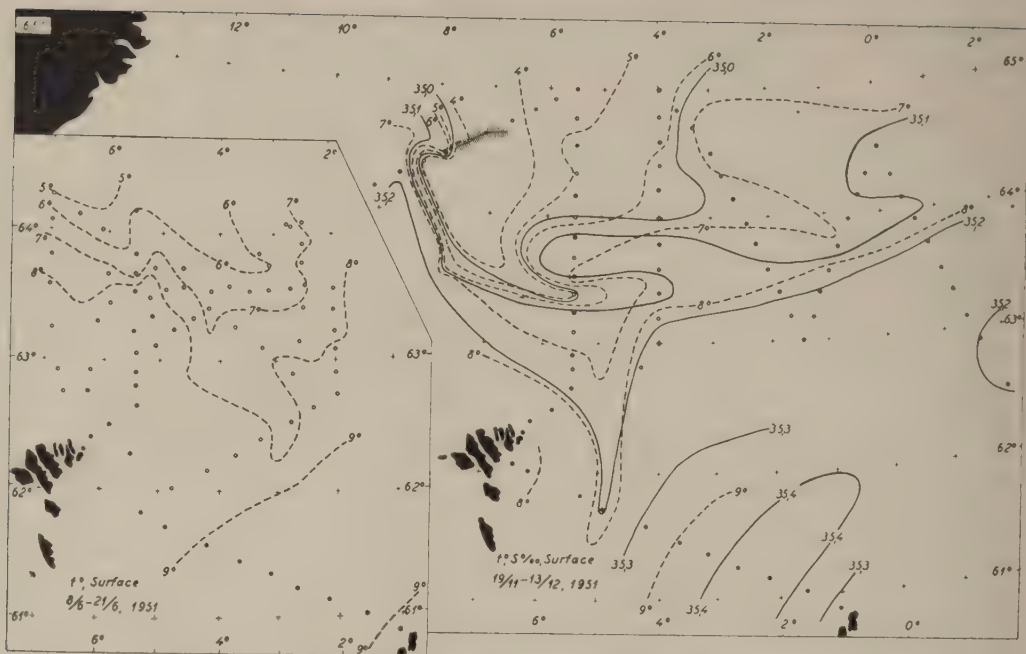


Figure 5. Surface temperature and salinity. The hatching indicates herring shoals.

had occurred and was present to a considerable depth at the time of observation.

The main purpose of these hydrographical investigations was to contribute to the understanding of the migrations of the herring in the Norwegian Sea. As the current system was supposed to be an essential feature in connection with the migrations, computations of the

currents were carried out on the November-December observations. The result is given in Figure 12, which shows the geopotential topography of the surface referred to the 1000 decibar level. On stations with depth less than 1000 m. *adp* was integrated along the bottom from a deeper station.

The herring shoals observed on the winter cruise of the "Dana" are marked on both Fig. 5 and Fig. 12. In the same area very thorough herring investigations were carried out by the Norwegian vessels "G. O. Sars" and K.N.M. "Andenes" in December and January. The herring shoals which according to FINN DEVOLD<sup>2)</sup> were observed from these ships, are also marked on the current chart Figure 12.

While the herring shoals in December were found in a pocket of cold water with temperature below 4°, they were, according to FINN DEVOLD, found at higher temperatures in the first half of January and, as seen in Figure 12, were mainly in the area with the strongest east-going currents. The calculated currents and the herring observations of K.N.M. "Andenes" are not simultaneous, but it is assumed that the main features of the currents remained constant for some time. It seems that the herrings are able to take advantage of



Figure 6. Distribution of temperature, 20 metres.

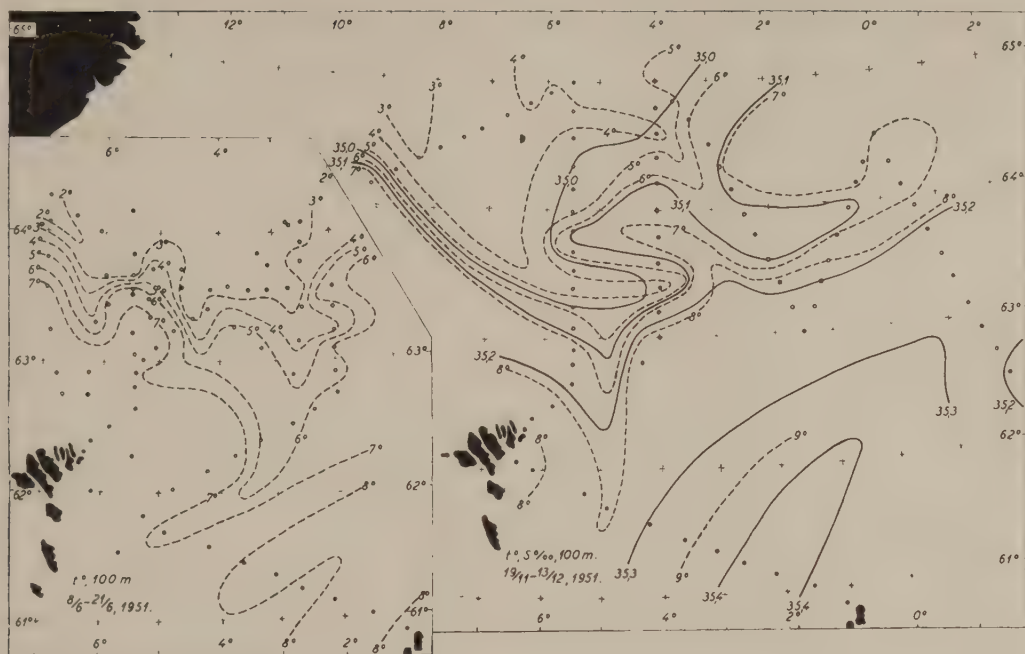


Figure 7. Distribution of temperature and salinity, 100 metres.

the strong east-going currents in the boundary between the cold and the warm water during the migration towards the spawning places.

During the cruises of "Dana", drift-bottles were liberated on the stations shown in Figure 4. As was to be expected, most of the returns came from the west coast of Norway. While all the returns from the June drift-bottles came after periods of drift of more than 100 days,

some of the winter drift-bottles stranded after remarkably short times. From the southernmost stations, i.e. Nos. 7770, 7774 and 7795, the first returns showed average velocities of about 10 miles per day and were found on the Norwegian coast between latitudes 63°N. and 66°N. The more northerly liberated bottles had considerably longer drift periods. Of special interest for the herring investigations

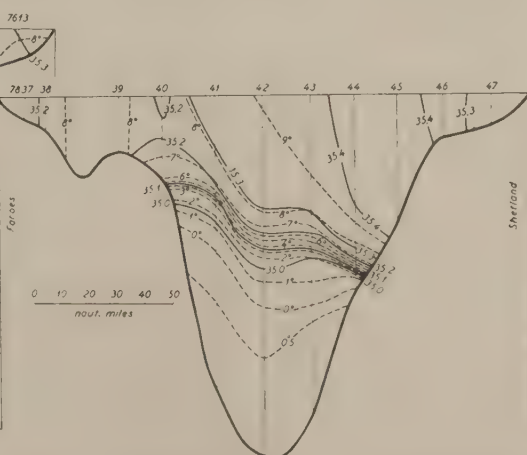
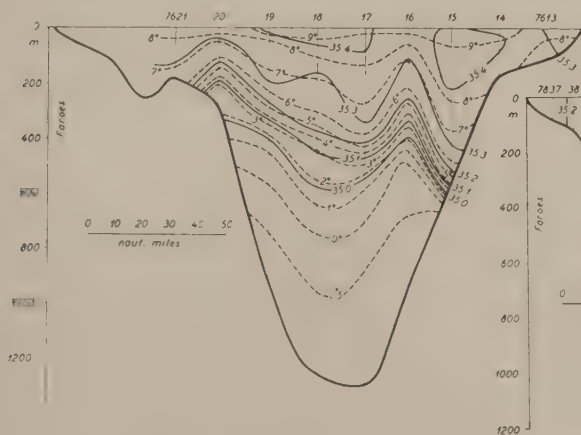


Figure 8. Faroe-Shetland section, 7—9. June, 1951. Figure 9. Faroe-Shetland section, 10—13. December, 1951.

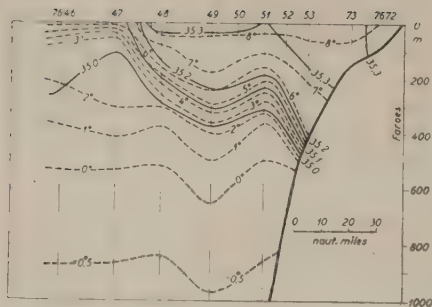


Fig. 10. Section from the Faroes northwards, 11—17. June, 1951.

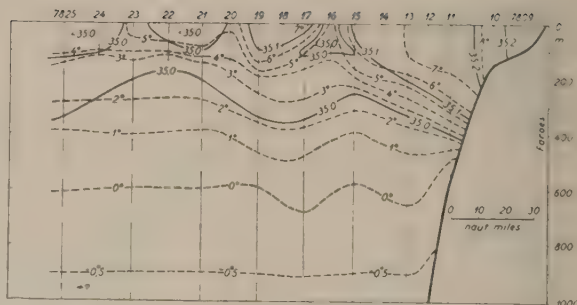


Figure 11. Section from the Faroes northwards, 1—3. December, 1951.

are the drift-bottles liberated at station 7832 on 4. December near the north-western limit of the area, where herring shoals were located in the beginning of December. The first return came from the Norwegian coast at latitude  $63^{\circ}20'N$ . on 26. February 1952, that is about one month later than the first catches of herrings off the Norwegian coast. Taking into account that the bottle may have been lying for some days on the shore before it was found and that it was liberated among the most

distant herring shoals, we may conclude that the speed of migration of the herrings was not essentially higher than the rate of drift of the bottle. This supports the assumption that the migration is partly a passive drift with the current.

FREDE HERMANN.

<sup>1)</sup> DEVOLD, FINN: Paa jakt efter storsilden i Norskehavet. Fiskets Gang, Nr. 20, 1951, p. 217.

<sup>2)</sup> DEVOLD, FINN: "G. O. Sars" tok under sildens innsig vinteren 1951—52. *ibid.*, Nr. 11, 1952, p. 130.

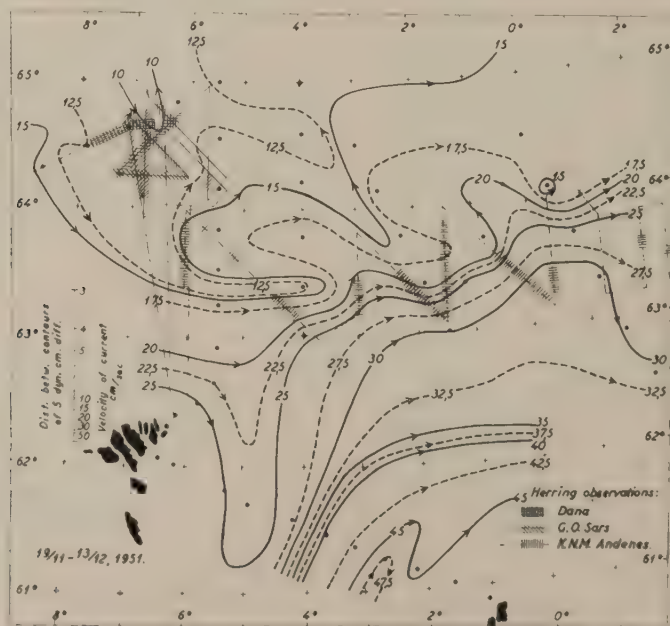


Figure 12. Geopotential topography in dyn. cm. surface relative to 1000 decibar surface. Herring observations from R/V "Dana" 4. December, 1951. R/V "G. O. Sars" 7—11. December 1951 and K.N.M. "Andenes" 7—13. January 1951.



## Section from the Faroe Islands westwards.

The section from the Faroes along latitude  $62^{\circ}\text{N.}$  was, in 1951, worked to  $21^{\circ}\text{W.}$  The distribution of temperature and salinity is shown in Fig. 13. The section was previously worked in 1938, 1948 and 1950 at the same time of the year. The main features found in 1951 were the same as in the previous years, with a nearly homogeneous layer between 200 and 700 metres and with relatively cold water from the Norwegian Sea on the slope off the Faroes.

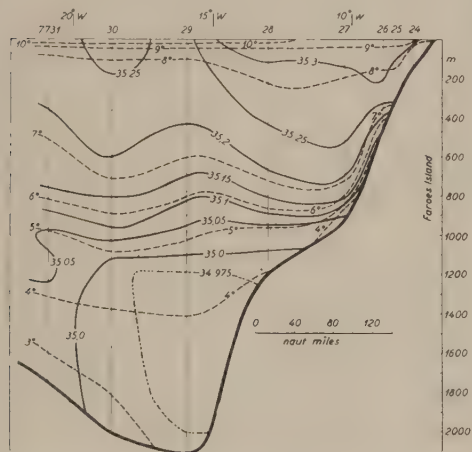


Figure 13. Section from the Faroes along  $62^{\circ}\text{N.}$ ,  
25°–27°, June 1951.

The section does however show a decrease in temperature and this decrease is given in Table 4 in which the mean temperatures at different depths at the deep stations between  $10^{\circ}\text{W.}$  and  $22^{\circ}\text{W.}$  are compared with the temperatures found in 1938.

Table 4 A shows that apart from the upper 50 metres, the temperatures down to

600 m. were in 1948 almost the same as those in 1938. Below 600 m. a decrease has taken place. Since 1948 the temperature from 100 to 800 m. has decreased and in 1951 the water in this thick layer was from  $0.5^{\circ}$  to  $0.8^{\circ}$  colder than in 1938.

As shown in Table 4 B, the salinity also has decreased since 1938. The decrease is however not very pronounced and seems not to have continued after 1948.

FREDE HERMANN.

Hydrographic Conditions in the Iceland Sea  
1951.

During the summer months extensive hydrographic investigations were carried out in the Icelandic coastal waters and in the area between Iceland, Greenland and Jan Mayen.

Figures 14–19 show the distribution of temperature and salinity at the surface and at 50 metres during three observation periods. The main features of these charts are the same as those found in previous years. Thus at the surface the isotherms and the isohalines are seen to lie closest near the ice limit and at the Iceland-Faroe Ridge. On the charts of observations at the 50 metres level the East Icelandic Current which appears as a tongue of cold water with relatively low salinity can be followed from its origin at about  $68^{\circ}$ – $69^{\circ}\text{N.}$ ,  $20^{\circ}\text{W.}$  towards the south-east along the slope of the Icelandic submarine platform. These charts also illustrate the gradual cooling of the east-moving Atlantic water along the north coast of Iceland. Comparing the years 1949, 1950 and 1951, it can be stated that in the north Icelandic coastal area the surface temperature during the summer of 1951 was similar to that in 1949 and 1950, but in August 1951 the warm surface water did not extend

Table 4. Increase in Temperature and Salinity since 1938 at  $62^{\circ}\text{N.}$ ,  $10^{\circ}\text{W.}$ – $22^{\circ}\text{W.}$

## A. Temperature increase.

| Depth m.  | 0     | 50    | 100   | 200   | 300   | 400   | 600   | 800   | 1000  | 1500  |
|-----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1948..... | –0.56 | +0.25 | –0.12 | –0.02 | –0.03 | +0.03 | –0.07 | –0.52 | –0.50 | –0.15 |
| 1950..... | –0.40 | +0.45 | –0.19 | –0.28 | –0.27 | –0.30 | –0.40 | –0.59 | –0.23 | +0.05 |
| 1951..... | +0.10 | –0.10 | –0.45 | –0.51 | –0.51 | –0.48 | –0.63 | –0.81 | –0.65 | +0.04 |

## B. Salinity increase.

| 1948..... | –0.06 | –0.05 | –0.06 | –0.04 | –0.04 | –0.04 | –0.03 | –0.07 | –0.09 | 0.00  |
|-----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1950..... | –0.04 | –0.07 | –0.06 | –0.06 | –0.06 | –0.06 | –0.06 | –0.08 | –0.07 | –0.01 |
| 1951..... | +0.01 | –0.01 | –0.04 | –0.05 | –0.05 | –0.06 | –0.06 | –0.07 | –0.09 | –0.02 |



Figure 14.



Figure 15.

as far north as it did in the same month of 1949 and 1950. The ice conditions were also rather unusual during this summer; thus, the ice limit was observed to the NW. of Kögur on the north-west coast of Iceland at a distance of about 80 miles in the beginning of May, about 60 miles around the beginning of July, about 90 miles in late July, but only 40 miles

off-shore around the middle of August. In ordinary years, however, the drift ice has mostly disappeared from the coast of East Greenland in August.

Figure 20, a—c, shows the hydrographic conditions in the section off Kögur on 3. July, 20. July and in the middle of August. It is seen that the vertical extension of Atlantic



Figure 16.



Figure 17.



Figure 18.



Figure 19.

water is greatest on 20. July, the extension at this time being similar to what it was at the end of July 1950 and about twice as much as it was in the middle of August 1949.

Figure 21, a—c, shows the situation in the section off Siglufjörður. In the uppermost 300 metres the temperature at the first three stations is seen to have increased throughout the summer. For instance, the 4°-isotherm is at about 200 metres depth in early July, at 250 m. in late July and at about 325 m. in late August. Below 300 metres depth, however,

there has not been an increase in temperature in July. The salinity is at all times relatively high or above 34.9 ‰ in most of the section. As is usually observed, the thickness of Atlantic water was greatest in August, in late July, however, it was somewhat less than it was at the beginning of the month.

Figure 22 shows the section extending from NE. Iceland to Jan Mayen. The general features of this section are essentially the same as those found in 1949. Thus, in both years great masses of cold Arctic water occupied the upper layers

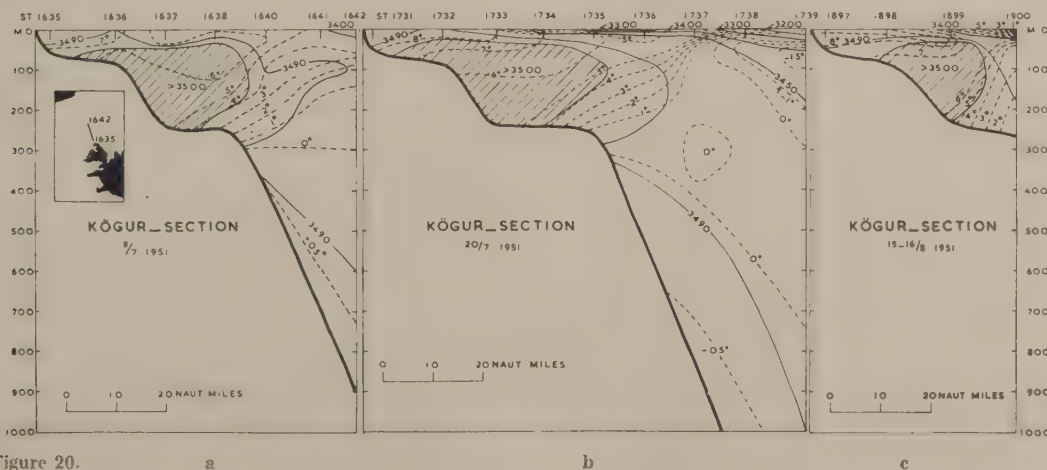


Figure 20.



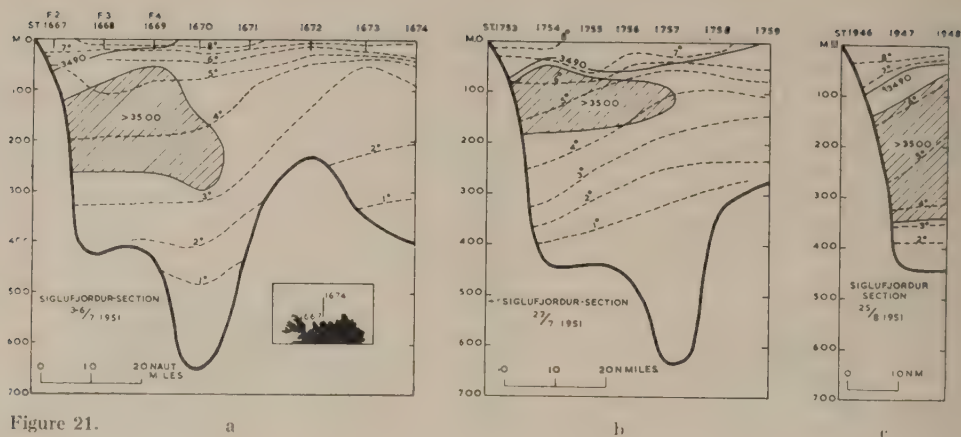


Figure 21.

in the middle part of the section. There was even more cold water in 1951. At the core of the East Icelandic Current the  $0^{\circ}$ -isotherm rose from about 300 metres to less than 100 metres to fall again farther north. At the Jan Mayen bank the salinity was quite high in the surface layers, approaching the value of the Atlantic water. This must have been due to some admixture with Atlantic water coming from the east or south-east. In the Icelandic coastal area the Atlantic water appeared as a tongue of relatively warm and saline water. The hydrographic conditions in this area were similar to those of 1950; due to the stronger influx of Atlantic water, however, the coastal water was much warmer than it was in 1949.

### Sea Temperatures and the Cod Fishery.

Off the coast of West Greenland we find a north-going current carrying partly cold water from the East Greenland Polar Current and partly warm water from the western arm of the Irminger Current. Variations in the volumes of the cold and warm water masses, which are intermixed on the northward run, may naturally be expected to have certain influences on the fishery.

On the basis of various publications on the hydrographic conditions in this area and from our own observations we are able to form an idea of the relation between changes in temperature conditions and the variations in the fishery on the banks off West Greenland. In early summer the volume of the cold East Greenland Polar Current is comparatively small, and along the western slope of the banks we may therefore find relatively warm water in depths of 150—300 metres. This is the area where the long-line fishery generally starts at this time of the year. The shallow parts of the banks are covered in spring and early summer by cold water cooled from the surface during the past winter. As the summer season advances the volume of the cold Polar Current increases until it reaches a maximum, generally in July. At the same time the water covering the shallow parts of the banks becomes warmer due to the influence of the sun and of the air temperature. Generally the cold Arctic Current decreases in volume again during August when the warm Irminger Current exerts more influence. The current of warm water reaches its greatest volume in autumn or early winter.

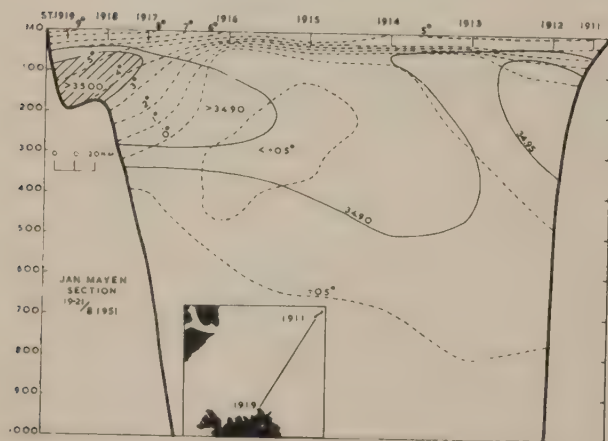


Figure 22.

UNNSTEINN STEFÁNSSON.

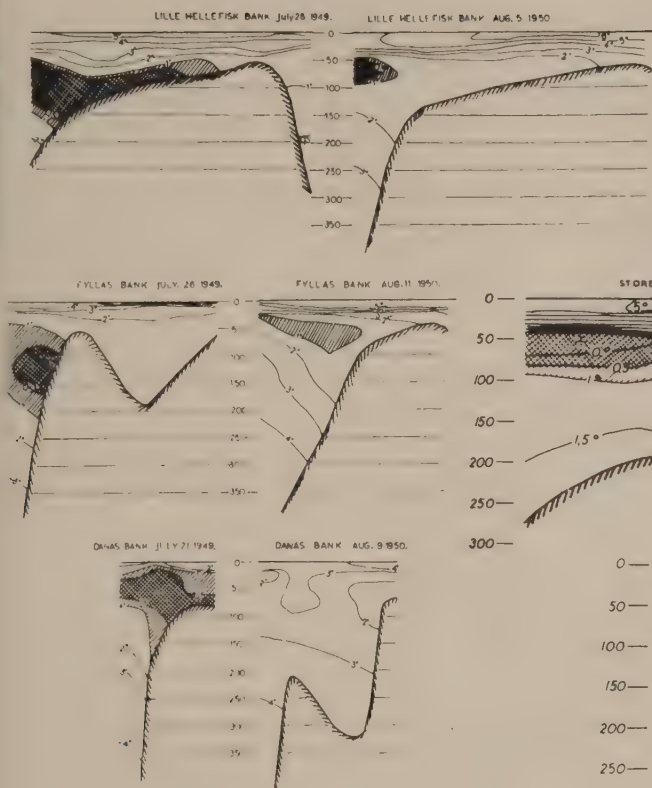


Figure 23. Temperature conditions off the western slopes of the banks in the Davis Strait in 1949 and 1950 during the so-called "slack season" of the fishery.

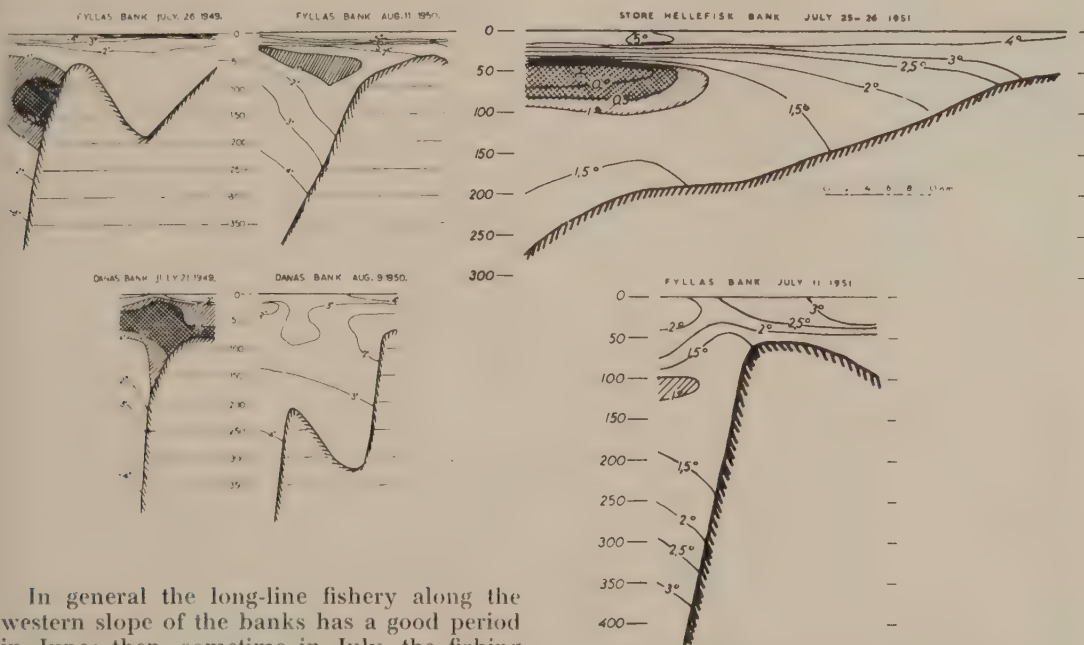


Figure 24. Temperature conditions on the western slopes of Store Hellefiske Bank and Fyllas Bank in July 1951.

In general the long-line fishery along the western slope of the banks has a good period in June; then, sometime in July, the fishing there becomes slack, and the slack period lasts until the latter half of August. Such at least has been the experience of the Norwegian fishermen during the last three seasons.

In Figure 23 is shown the temperature conditions on the western slope of Danas Bank, Fyllas Bank and Lille Hellefiske Bank during the so-called "slack period" of the cod fishery. At some distance off the slope in July-August we find a layer of cold water with temperatures usually below  $1^{\circ}\text{C}$ . Above and below this central core of cold water we find water masses with temperatures between  $1$  and  $2^{\circ}\text{C}$ ., the cold water below  $2^{\circ}\text{C}$ . stretching eastwards and covering the slopes of the banks in depths between approximately 75 and 250 metres. Below and above these depths the temperatures are higher. The shallow banks are covered with comparatively warm water.

Our experience from fishery investigations in the Spitsbergen and Bear Island area has been that cod fishing is hardly profitable where bottom temperatures are below  $2^{\circ}\text{C}$ . British trawl experiments on the Bear Island Bank have shown that bottom temperatures around  $1.75^{\circ}\text{C}$ . may be reckoned as the lower limit for profitable cod catches. Our fishing experiments in West Greenland waters indicate that here also profitable fishing cannot be expected if bottom temperatures are below  $2^{\circ}\text{C}$ .

The temperature condition on the slopes of Fyllas Bank and Store Hellefiske Bank in July 1951 is shown in Figure 24. In that year the Norwegian fishermen made satisfactory

catches along the western slopes of all banks in May-June in depths from 135 to 270 metres. Early in July the fishing suddenly became very slack particularly on the southern banks. The fishermen left the southern grounds and sailed northwards to Store Hellefiske Bank where the fishery could still be carried on for a while with satisfactory results. But here also towards the end of July, the fishing became rather discouraging. We may presume that towards the end of June the current of cold water increased in volume and pushed closer towards the banks where it lay for a while as a belt along the western slopes. The hydrographic sections show that in July the cold water with temperatures below 2°C. covered the bottom in depths where fishing is generally carried on. The fishery in this period was slack. The cod would find more suitable temperature conditions in deeper water or on the shallow part of the bank where the temperature in July-August was above 3°C.

The observations in West Greenland waters indicate that the cod prefer to seek shallow water when they are forced away from the slopes of the banks by a drop in temperature. In the upper water layers we find, during the "slack period", better temperature conditions and a rich production of pelagic food organisms. The cod will also find rich feeding grounds on the bottom on the shallow parts of the banks where the depths are only 40—75 metres. Here we can observe great swarms of sandeels and capelan at this time of the year. The cod is here able to find such quantities of fresh food that they do not take the frozen bait generally used on the long-lines at all well.

In 1951 the fishery along the western slopes recovered gradually from the middle of August, and it remained quite satisfactory till the ships went home in early October.

BIRGER RASMUSSEN.

## Plankton.

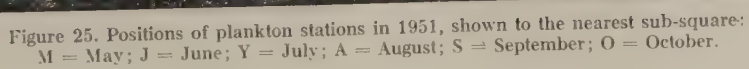
### Investigations from Scottish Research Vessels.

The Scottish vessels "Explorer" and "Scotia" paid a number of visits to Faroese waters during 1951. The investigations on the plateau were mainly concerned with the larval fish populations, and as such are separately reported by Mr. SAVILLE. Traverses from the Butt of Lewis to Faroe Bank and Faroe, and from Faroe to Shetland were made as often as possible on these cruises throughout the year. In June the "Scotia" investigated the hydrography and plankton of the area between and beyond Faroe, Lousy Bank, Rockall and Porcupine Banks, and in August traverses between Faroe and Iceland, and between Iceland and the west coast of Scotland were made. The positions of plankton stations (excluding the numerous stations for fish larvae on Faroe Plateau and other inshore positions) are shown in the accompanying chart, Figure 25.

During the spring and early summer *Calanus finmarchicus* was very abundant over the whole

of the northern area investigated including Faroe Plateau, Faroe Channel, Rosemary and Lousy Banks and off the west Scottish coast. It was much less abundant or even rare on Porcupine and Rockall Banks but was present in fair numbers off the west and north Irish coasts. By late summer it was still common to the west of Faroe, between Faroe and the Hebrides, off the west coasts of Scotland and near Shetland, but its numbers were considerably reduced north and east of Faroe and on Rosemary and Lousy Banks. It was, however, common off the south-east coast of Iceland and between Lousy Bank and Iceland. *Calanus helgolandicus* was present off the Scottish and Irish west coasts. *Rhincalanus nasutus*, *Eucalanus elongatus* and *Euchaeta norvegica* were associated with *Calanus finmarchicus* in all areas except the Icelandic coast where *Rhincalanus* and *Eucalanus* were not found. Many bathypelagic species of copepods were taken in the deep water. The cold water species *C. hyperboreus* and *Metridia longa* were both present on the Faroe Shetland line and the





Faroe-Butt of Lewis line north of the edge of the continental shelf. Only isolated specimens were found further south though their deep water distribution extended as far south as Porcupine Bank and the deep water near it.

Euphausiids were chiefly represented by *Meganyctiphanes norvegica* and *Thysanoessa longicaudata*; although these were not common in the first half of the year they became generally abundant throughout the northern sectors from July onwards.

The cold water Chaetognatha *Sagitta maxima* and *Eukrohnia hamata* had a distribution similar to, but more definite than the cold water copepods. The surface oceanic species *Sagitta serratodentata* was, however, widely distributed in the upper layers of the whole area except to the north of Faroe and off the east Icelandic coast. Some specimens were found in the neighbourhood of Orkney and in the Moray Firth in February to May, but they were not taken in the Shetland region until much later and entered the northern North Sea round Shetland between July and December. The warm water species *S. lyra* was commonly found in the region of Porcupine Bank in June but was not then taken at Rockall, Rosemary Bank or in the Faroe Channel, though it was taken along the edge of the continental shelf in August, confined to the region south of the Wyville Thomson Ridge. A single occurrence was noted between Faroe and Shetland (A 21 c) in July.

Of the pteropods, *Clione limacina* was present at almost all stations; *Clio pyramidata*, and less commonly *C. cuspidata*, were found west of Ireland and over deep water between Scotland and Rockall and Rosemary Bank in June, but were not recorded as penetrating to the Faroe Channel except to the south of the Wyville Thomson Ridge. Salps (*S. fusiformis*) and doliolids (*D. gegenbauri*) were found together in fair numbers in the area west of Ireland in June, though their distribution elsewhere would suggest that their mixing was a secondary development, having originated from separate sources. The doliolids were present in the area north-west of the Butt of Lewis in June and thereafter they became distributed in the northern Minch and in the area west of Orkney. The salps, however, were distributed much further north and entered the Faroe Channel north of the Wyville Thomson Ridge being present east of Faroe from July to October, though they were also present on the

Faroe-Shetland line and entered the northern North Sea east of Shetland in October. *Thalia democratica*, which has not been abundant in the Scottish area since 1904, was recorded (though not in large numbers) west of Ireland (QQ6c) in June and again near the southern entrance to the Minch (XX12a) in October.

Of special interest in 1951 are the warm water species, chiefly coelenterates, both east and west of Porcupine Bank. These include 18 specimens of siphonophores; the medusae *Rhopalonema*, *Periphylla* and *Nausithoë*; and the pelagic annelids *Travisopsis* and *Vanadis*. Of these only a few reached the Faroe Channel (*Hippopodius*, *Chuniphyes multidentata*, *Rosacea plicata*, *Nausithoë*) where they became mixed with some of the species from the west (*Salpa fusiformis*, *Agalma elegans*) and boreal species (*Sagitta maxima*, *Physophora*, *Dimophys arctica* etc.); only *Salpa*, *Agalma*, and *Physophora* were recorded as entering the North Sea though *Hippopodius* was found in December over the Norwegian Deep at 61°N.

This picture of the plankton distribution can be linked with the water movements of the area and adds convincing evidence to confirm hydrographical deductions. Thus there appears to have been a rich oceanic fauna of Biscayan or Lusitanian origin which approached the deep water channel between Scotland and Rockall Bank, by way of the Porcupine Bank area. It was here met by a southward flowing deep water stream of boreal origin (containing *Calanus hyperboreus*, *Metridia longa*, *Sagitta maxima*, *Eukrohnia hamata*, *Physophora* etc.) which thus destroyed the conditions suitable for the survival of most of the warm water exotic species. That some water containing the Biscayan species continued north is shown by the passage of *Sagitta lyra*, *Thalia democratica*, *Doliolletta gegenbauri*, *Chuniphyes*, *Rosacea*, *Hippopodius* etc., but that the pressure of this water was relatively weak is shown in that the doliolids off the north Scottish coast did not penetrate as far as the North Sea. The main thrust of oceanic water in the Faroe Channel and across the Faroe-Shetland line was not of Biscayan origin but came from the open north-east Atlantic and contained *Salpa fusiformis*, *Clione limacina*, *Agalma elegans* and *Physophora*, although even this stream in 1951 had but small effect in the northern North Sea. The mixing of north-eastern Atlantic species with those of Biscayan origin in the area around Porcupine Bank and to a lesser degree round

Rockall Bank would appear to suggest that much of the Biscayan water remained in this area, probably in the form of a swirl.

The usual autumn abundance of *Aurelia aurita* in Faroese waters started early in 1951,

and it was fairly widespread there by July. By September there was the usual abundance of large specimens.

J. H. FRASER.

## THE FISH

### Eggs and Larvae.

#### Faroes.

#### Fish Eggs and Larvae at Faroe.

An intensive survey of Faroe waters, similar to that reported for 1950, was again carried out. The data are rather less adequate, however, as the area was surveyed only during the periods 25. April—4. May; 20. May—31. May, and 15.—23. July. The station grid and station procedure was similar to those of the 1950 survey.

#### Haddock.

The haddock spawning season at Faroe would seem to have been somewhat later in beginning than in 1950. No larvae greater than 7 mm. were taken during the first cruise, which would place the first spawning about the second week of March. Spawning was again over by the second week of May, having attained its peak in the first fortnight of April. Areas of greatest spawning intensity showed minor variations from those found in 1950. The area of high egg density to the north of the islands was more extensive—stretching from the longitude of Myling Head to Fuglø Bank. Haddock eggs were comparatively scarce over Nolsø Bank but an area of high egg density overlay the edge of the shelf east of Sandø. To the west of the islands only one small area of high density west of Myggenæs was found. The distribution of the subsequent larval stages varied even more widely between the two years—the 1951 brood being concentrated to the north of the islands instead of in the southern half of the plateau as in the previous year.

The total spawning effort of the Faroese haddock stock was estimated on the same basis as for 1950 and is liable to the same errors.

The figure arrived at is  $3 \times 10^{12}$  eggs spawned by the Faroese haddock stock in the 1951 season. This figure is about one third of that calculated for the 1950 season. Growth data are again best fitted by an assumption of exponential growth in which the increase per day of the logarithm of the length is 0.01. Mortality estimates are badly handicapped by the fact that no cruise was carried out in June and accordingly no group of eggs can be followed through their development beyond a size of 10 mm. The mortality rates arrived at, however, are 5 % per day during the egg stage, 8.5 % hatching mortality and 3.4 % per day subsequently up to a size of 10 mm. It will be observed that these rates are considerably smaller than those deduced for the 1950 season. As a result, in spite of the smaller egg production, three times as many larvae can be expected to have attained a size of 10 mm. in 1951 as in 1950 and unless mortality increased markedly above this size the prospects for the 1951 haddock brood would appear better than for that of 1950.

#### Cod.

The cod spawning season at Faroe in 1951 again appears to have been about a week earlier than that of the haddock and to have had very similar centres of density. The total cod spawning assessment was about four times that of haddock—although it should be noted that the significance of this difference cannot be assessed. Growth in the cod larvae showed the same characteristics as in haddock and there was a similar reduction in mortality rates compared with the preceding year, these being 6.5 % per day egg and hatching mortality and 3.5 % per day subsequently.

ALAN SAVILLE.



# **Occurrence of pelagic 0-group Cod, Haddock, Whiting and Coalfish, Summer 1951.**

A survey of the pelagic fish larvae in the Faroe area was carried out by the "Dana" in the middle of June (Fig. 26 and Table 5).

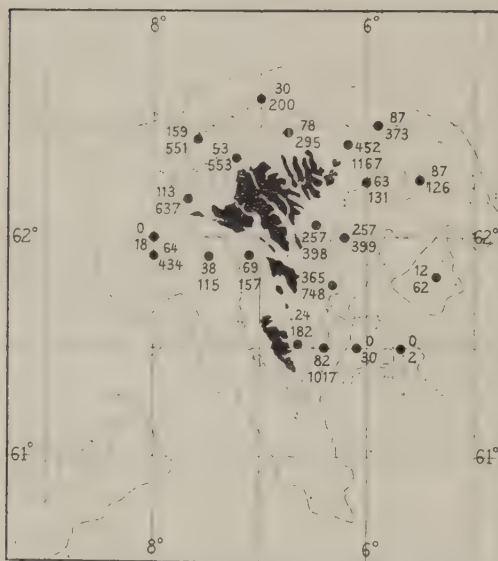


Figure 26. Number of larval stages of cod (above) and haddock (below) per 1-hour haul with a 2-metre stramin-net, 9.—24. June 1951.

With few exceptions the samples were collected between 13. and 17. June. Compared with the numbers found in June in previous years the average number of cod-fry (111 per 1-hour

**Table 5. Larval Cod, Haddock, Whiting and Coalfish.**

Total catch on 21 stations<sup>1)</sup> over depths between 50 and 200 m. June 1951.

| Length (mm.)          | Cod                | Haddock            | Whiting | Coalfish |
|-----------------------|--------------------|--------------------|---------|----------|
| 5—9.....              | 120                | 1057               | 41      | 2        |
| 10—14.....            | 547                | 2569               | 290     | 8        |
| 15—19.....            | 796                | 1050               | 157     | 21       |
| 20—24.....            | 521                | 308                | 19      | 21       |
| 25—29.....            | 163                | 67                 | 1       | 10       |
| 30—34.....            | 32                 | 6                  | —       | 3        |
| 35—39.....            | 9                  | 3                  | —       | 2        |
| 40—45.....            | 1                  | —                  | —       | —        |
| Total Number.....     | 2278 <sup>2)</sup> | 7504 <sup>3)</sup> | 508     | 67       |
| Number per hour....   | 111                | 366                | 24      | 3.4      |
| Average length, mm. . | 18.0               | 13.3               | 14.2    | 21.1     |

<sup>1)</sup> On each station two oblique hauls of 3 × 10 minutes each were made with 2-m. stramin nets (100—50—25 and 200—150—125 m. of wire out).

<sup>2)</sup> Including 89 specimens not measured.

<sup>3)</sup> .. 2444 .. ..

haul) was low. The average length (18.0 mm.) was higher than that usually found in this month (13—15 mm.). As this indicates that the peak abundance of the 0-group cod had occurred somewhat earlier in the season than usual the observed low number of larvae gives no reason to believe that the strength of the year-class is below the normal.

As in the other post-war years when similar investigations were carried out in this area, the average number of haddock fry (366) per 1-hour haul was higher than before the war. If their average length of 13.3 mm., which compares with an average for all previous collections in June of 12.3 mm., is taken into consideration, then this number indicates that the haddock brood of 1951 was more abundant than that of 1950 but not quite as rich as those of 1947 and 1948.

E. BERTELSEN.

## **Haddock.**

Extensive surveys of the haddock population at Faroe have been carried out by F. R. S. "Scotia" between April and September 1951, samples being taken by means of one hour hauls with a covered otter trawl. In addition, the age and size composition of haddock landed at Aberdeen fish market by trawlers fishing at Faroe has been determined, the landings of four or five ships per month being sampled for this purpose.

## **Age Composition.**

The age composition of haddock sampled by "Scotia" and from commercial trawlers is shown in Tables 6 and 7 A respectively. The size composition of the commercial landings is shown in Table 7 B; by converting these mean lengths to weights (using data from RUSSELL, 1914), and then multiplying each by

**Table 6. Age Composition of Haddock caught by F. R. S. "Scotia" at Faroe — 1951.**

| (Excluding Faroe Bank). |             |                           |     |
|-------------------------|-------------|---------------------------|-----|
| Year-class              | No. of Fish | No. of Hours Per 10 Hours |     |
| 1951                    | 1290        | 24                        | 538 |
| 1950                    | 2355        | 65.5                      | 360 |
| 1949                    | 1656        | 65.5                      | 253 |
| 1948                    | 465         | 65.5                      | 71  |
| 1947                    | 41          | 65.5                      | 6   |
| 1946                    | 16          | 65.5                      | 2   |
| 1945                    | 25          | 65.5                      | 4   |
| 1944                    | 45          | 65.5                      | 7   |
| Total All Ages          | 5893        | 482.5                     | 122 |

Table 7. Aberdeen Trawlers' Market Samples - Faroe Haddock - 1951.

## A. Number landed/10 hrs. Fishing.

| Year-Class. | Jan.  | Feb.  | March | April | May   | June  | July  | Aug.  | Sept. | Oct.  | Nov.  | Dec.  |
|-------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1950.....   | —     | —     | —     | —     | —     | 2.3   | —     | 9.0   | 6.2   | 86.0  | 220.5 | 94.6  |
| 1949.....   | 90.8  | 20.8  | 30.1  | 1.7   | 477.6 | 281.7 | 847.8 | 727.1 | 839.2 | 794.8 | 551.6 | 656.4 |
| 1948.....   | 619.3 | 347.8 | 644.9 | 445.5 | 473.1 | 226.0 | 549.4 | 248.5 | 258.0 | 185.4 | 178.6 | 159.2 |
| 1947.....   | 81.2  | 35.2  | 84.6  | 342.8 | 52.1  | 30.9  | 66.7  | 40.1  | 33.7  | 16.2  | 12.3  | 15.1  |
| 1946.....   | 11.5  | 14.9  | 22.5  | 52.7  | 25.8  | 9.0   | 5.2   | 6.5   | 8.2   | 1.5   | 0.4   | 14.6  |
| 1945.....   | 17.1  | 9.6   | 41.9  | 106.5 | 43.3  | 13.3  | 33.0  | 34.2  | 23.8  | 8.2   | 7.7   | 16.9  |
| 1944.....   | 24.9  | 56.7  | 61.0  | 190.9 | 58.8  | 16.7  | 42.7  | 28.8  | 58.2  | 20.1  | 6.5   | 26.7  |
| 1943.....   | 15.3  | 12.6  | 28.1  | 29.2  | 22.2  | 4.9   | 37.4  | 19.3  | 20.1  | 10.8  | 3.8   | 11.1  |
| 1942.....   | 2.3   | 2.3   | 7.4   | 10.6  | 4.9   | 4.5   | 8.6   | 4.5   | 5.6   | 2.3   | 0.8   | 3.3   |
| 1941.....   | 3.9   | 3.9   | 3.1   | 4.9   | 1.6   | 1.3   | 4.5   | 1.5   | —     | —     | 0.7   | 3.3   |
| 1940.....   | —     | —     | 1.2   | 2.9   | 1.7   | —     | 0.4   | 1.0   | —     | —     | —     | —     |
| 1939+....   | —     | —     | 1.0   | 9.7   | 0.9   | 0.4   | —     | —     | —     | —     | —     | —     |

## B. Mean Lengths of each Age-Group sampled.

|           |      |      |      |      |      |      |      |      |      |      |      |      |
|-----------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1950..... | —    | —    | —    | —    | —    | 27.0 | —    | 27.6 | 25.5 | 29.0 | 30.1 | 29.6 |
| 1949..... | 30.7 | 31.9 | 31.5 | 26.0 | 32.1 | 33.0 | 33.0 | 34.8 | 34.9 | 35.6 | 38.8 | 36.8 |
| 1948..... | 39.4 | 42.0 | 39.7 | 40.8 | 41.0 | 42.1 | 41.1 | 44.3 | 45.5 | 46.6 | 49.1 | 46.6 |
| 1947..... | 49.6 | 51.4 | 50.2 | 48.5 | 49.3 | 49.1 | 49.6 | 51.4 | 53.3 | 52.3 | 55.3 | 53.2 |
| 1946..... | 50.7 | 53.4 | 53.2 | 52.4 | 54.2 | 54.2 | 52.8 | 55.1 | 53.2 | 55.9 | 61.5 | 56.0 |
| 1945..... | 53.8 | 54.8 | 56.6 | 54.0 | 55.3 | 56.0 | 56.0 | 56.9 | 56.7 | 58.6 | 61.0 | 58.2 |
| 1944..... | 60.6 | 59.7 | 60.0 | 58.1 | 59.9 | 60.0 | 59.1 | 59.0 | 60.6 | 61.5 | 63.5 | 60.6 |
| 1943..... | 64.0 | 66.2 | 63.6 | 65.3 | 62.8 | 64.5 | 62.3 | 63.9 | 63.3 | 63.7 | 65.5 | 63.6 |
| 1942..... | 61.0 | 67.5 | 69.6 | 68.5 | 65.3 | 67.7 | 70.6 | 68.7 | 66.9 | 70.8 | 68.0 | 67.5 |
| 1941..... | 68.5 | 67.3 | 70.8 | 76.0 | 74.8 | 70.2 | 67.5 | 72.2 | —    | —    | 71.5 | 69.0 |
| 1940..... | —    | —    | 81.1 | 72.8 | 74.2 | —    | 79.3 | 74.5 | —    | —    | —    | —    |
| 1939..... | —    | —    | 75.0 | 78.2 | 79.3 | 82.0 | —    | —    | —    | —    | —    | —    |
| 1938..... | —    | —    | —    | 81.0 | 82.0 | 87.0 | —    | —    | —    | —    | —    | —    |
| 1937..... | —    | —    | —    | 80.2 | 79.0 | —    | —    | —    | —    | —    | —    | —    |

## C. Estimated Weights\*) landed/10 hrs. fishing (in cwt.).

|            |       |      |       |       |       |      |       |       |       |       |       |       |
|------------|-------|------|-------|-------|-------|------|-------|-------|-------|-------|-------|-------|
| 1950.....  | —     | —    | —     | —     | —     | 0.01 | —     | 0.03  | 0.02  | 0.35  | 0.99  | 0.39  |
| 1949.....  | 0.42  | 0.10 | 0.14  | 0.01  | 2.44  | 1.60 | 4.94  | 5.10  | 5.91  | 5.98  | 5.53  | 5.35  |
| 1948.....  | 6.37  | 4.09 | 6.16  | 4.73  | 5.23  | 2.83 | 6.89  | 3.68  | 4.18  | 3.23  | 3.64  | 2.76  |
| 1947.....  | 1.70  | 0.79 | 1.61  | 6.09  | 0.99  | 0.60 | 1.36  | 0.94  | 0.89  | 0.40  | 0.37  | 0.40  |
| 1946.....  | 0.26  | 0.37 | 0.52  | 1.18  | 0.65  | 0.24 | 0.13  | 0.19  | 0.22  | 0.05  | 0.02  | 0.45  |
| 1945.....  | 0.47  | 0.26 | 1.12  | 2.64  | 1.18  | 0.39 | 1.00  | 1.11  | 0.75  | 0.29  | 0.31  | 0.59  |
| 1944.....  | 0.98  | 2.00 | 2.04  | 6.14  | 2.08  | 0.61 | 1.51  | 1.04  | 2.25  | 0.83  | 0.29  | 1.06  |
| 1943.....  | 0.71  | 0.64 | 1.11  | 1.31  | 0.91  | 0.23 | 1.55  | 0.87  | 0.88  | 0.48  | 0.18  | 0.49  |
| 1942.....  | 0.09  | 0.11 | 0.39  | 0.58  | 0.22  | 0.25 | 0.53  | 0.26  | 0.28  | 0.12  | 0.04  | 0.18  |
| 1941.....  | 0.02  | 0.19 | 0.17  | 0.33  | 0.10  | 0.08 | 0.23  | 0.10  | —     | —     | 0.04  | 0.19  |
| 1940.....  | —     | —    | 0.08  | 0.18  | 0.11  | —    | 0.03  | 0.06  | —     | —     | —     | —     |
| 1939.....  | —     | —    | 0.06  | 0.68  | 0.06  | 0.03 | —     | —     | —     | —     | —     | —     |
| Total..... | 11.02 | 8.55 | 13.40 | 23.87 | 13.97 | 6.87 | 18.18 | 13.37 | 15.38 | 11.73 | 11.41 | 11.86 |

Actual landings per 10 hours by Aberdeen

|             |       |      |       |       |       |      |       |       |       |       |       |       |
|-------------|-------|------|-------|-------|-------|------|-------|-------|-------|-------|-------|-------|
| trawlers... | 10.83 | 8.66 | 13.16 | 23.03 | 13.33 | 5.73 | 17.45 | 13.13 | 14.78 | 12.05 | 10.76 | 12.10 |
|-------------|-------|------|-------|-------|-------|------|-------|-------|-------|-------|-------|-------|

\*) Estimated using data from RUSSELL, 1914.

the appropriate number per 10 hours fishing (Table 7 A), estimates of the weights of each brood landed per 10 hours fishing have been made (Table 7 C).

The commercial landings were composed of haddock of one to thirteen or more years in age, of which the principal were the 1943, 1944, 1945, 1947, 1948 and 1949 broods. Comparison with the previous year's data (JONES, 1951) indicate that the numbers per 10 hours fishing

of the 1950 and 1949 broods were considerably lower during 1951 than were corresponding landings of the 1949 and 1948 broods during 1950.

The 1951 brood, which was sampled by "Scotia" in September and October of that year, averaged 538 per 10 hours fishing which is much greater than the corresponding catches of the 1950 brood at the end of 1950. This is to be classed as a good brood.

Table 8. Mean Lengths and Standard Errors

| Year-Class | Age | Month      | North-West |            |          | North        |                |           | North-East |            |          | East         |                |            |
|------------|-----|------------|------------|------------|----------|--------------|----------------|-----------|------------|------------|----------|--------------|----------------|------------|
|            |     |            | Mean       | S. E.      | No. fish | Mean         | S. E.          | No. fish  | Mean       | S. E.      | No. fish | Mean         | S. E.          | No. fish   |
| 1951       | 0+  | Sept. Oct. | 11.9<br>—  | 0.133<br>— | 159<br>— | 12.0<br>12.6 | 0.093<br>0.387 | 275<br>11 | —<br>12.6  | —<br>0.227 | —<br>63  | 12.0<br>13.0 | 0.064<br>0.707 | 473<br>4   |
| 1950       | 1+  | April      | —          | —          | —        | —            | —              | —         | 17.0       | —          | 1        | 15.7         | 0.069          | 709        |
|            |     | May        | 20.3       | 0.402      | 59       | 16.9         | 0.632          | 22        | 15.6       | 0.287      | 44       | 15.9         | 0.284          | 45         |
|            |     | June       | —          | —          | —        | —            | —              | —         | —          | —          | —        | —            | —              | —          |
|            |     | Aug.       | —          | —          | —        | —            | —              | —         | —          | —          | —        | —            | —              | —          |
|            |     | Sept. Oct. | 26.3<br>—  | 0.427<br>— | 41<br>—  | 26.5<br>24.8 | 0.246<br>0.300 | 100<br>26 | —<br>23.1  | —<br>0.249 | —<br>96  | 23.6<br>23.6 | 0.118<br>0.127 | 337<br>231 |
| 1949       | 2+  | April      | —          | —          | —        | —            | —              | —         | 23.0       | —          | 1        | 27.7         | 0.081          | 811        |
|            |     | May        | 32.8       | 0.207      | 174      | 30.6         | 0.371          | 58        | 26.5       | 0.609      | 19       | 25.9         | 0.481          | 45         |
|            |     | June       | —          | —          | —        | —            | —              | —         | —          | —          | —        | —            | —              | —          |
|            |     | Aug.       | —          | —          | —        | —            | —              | —         | —          | —          | —        | —            | —              | —          |
|            |     | Sept. Oct. | 36.7<br>—  | 0.749<br>— | 19<br>—  | 38.4<br>34.6 | 0.360<br>1.207 | 43<br>13  | —<br>30.0  | —<br>0.504 | —<br>56  | 33.1<br>33.4 | 0.359<br>0.184 | 100<br>162 |
| 1948       | 3+  | April      | —          | —          | —        | —            | —              | —         | 43.0       | 1.528      | 3        | 39.5         | 0.199          | 143        |
|            |     | May        | 42.1       | 0.440      | 67       | 41.3         | 0.452          | 36        | 39.6       | 0.585      | 36       | 35.2         | 1.497          | 8          |
|            |     | Sept.      | 46.9       | 1.022      | 11       | 45.8         | 0.898          | 13        | —          | —          | —        | 42.5         | 0.699          | 33         |
|            |     | Oct.       | —          | —          | —        | 47.3         | 0.885          | 3         | 40.7       | 1.440      | 15       | 42.1         | 0.411          | 49         |
| 1947       | 4+  | May        | 50.2       | 0.910      | 9        | 51.2         | 0.856          | 4         | 45.2       | 1.547      | 12       | 42.0         | —              | 1          |
|            |     | Sept.      | 51.0       | —          | 1        | 52.0         | 1.000          | 2         | —          | —          | —        | 53.0         | 4.000          | 2          |
|            |     | Oct.       | —          | —          | —        | —            | —              | —         | 47.0       | 3.000      | 2        | 45.5         | 5.500          | 2          |
| 1946       | 5+  | May        | 54.0       | —          | 2        | —            | —              | —         | 54.5       | 3.096      | 4        | —            | —              | —          |
|            |     | Sept.      | 60.0       | 3.000      | 2        | —            | —              | —         | —          | —          | —        | 57.0         | —              | 1          |
|            |     | Oct.       | —          | —          | —        | —            | —              | —         | 55.5       | 0.866      | 4        | —            | —              | —          |
| 1945       | 6+  | May        | 55.1       | 1.251      | 10       | —            | —              | —         | 58.7       | 2.029      | 3        | —            | —              | —          |
|            |     | Sept.      | 64.0       | —          | 1        | 60.0         | 1.000          | 2         | —          | —          | —        | 60.5         | 0.500          | 2          |
|            |     | Oct.       | —          | —          | —        | —            | —              | —         | —          | —          | —        | 53.0         | —              | 1          |
| 1944       | 7+  | May        | 60.5       | 0.510      | 28       | 60.2         | 0.748          | 6         | 62.3       | 1.282      | 6        | —            | —              | —          |
|            |     | June       | —          | —          | —        | —            | —              | —         | —          | —          | —        | —            | —              | —          |
|            |     | Sept. Oct. | —<br>—     | —<br>—     | —<br>—   | —<br>—       | —<br>—         | —<br>—    | —<br>52.0  | —<br>—     | —<br>1   | 61.7<br>—    | 2.405<br>—     | 3<br>—     |

**Size Composition.**

The mean lengths and standard errors for each brood sampled by "Scotia" during each month are shown in Table 8. The limits of the areas are defined in a previous issue of this journal (JONES, 1951). As in previous years, the largest fish caught were from Faroe Bank where, age for age, the fish were consistently larger than those taken anywhere on the shelf. Around Faroe, the largest fish were located in the north-west area, whilst the smallest were from Sandø Bank.

**Mortality Rate.**

An estimate of the percentage survival of each brood over an annual period measured from a given month in 1950 to the same month in 1951 has been made from market sample

data by simply taking the ratio of the number per 10 hours fishing of each brood in any month in 1950 to the corresponding figure for the same month in 1951. A pooled estimate was then made for the 1942—1947 broods (all months) and the 1948 brood (October-December); this was equal to 32 % survival, or a mortality rate of 68 % annually.

**The Commercial Fishery.**

The average weight of haddock landed per 100 hours fishing by Aberdeen trawlers from Faroe during 1951 is shown in Table 9. The average landing for the year, 125.7 cwt., is considerably lower than the average values of 156.5 and 151.2 attained during 1949 and 1950, but is still higher than the average for 1939 which was 96.2 cwt. It is noticeable too



## Stock of each Age-Group from Faroe - 1951.

| Year-Class | Age | Month | West |       |          | South |       |          | Sandø Bank |       |          | Faroe Bank |       |          |
|------------|-----|-------|------|-------|----------|-------|-------|----------|------------|-------|----------|------------|-------|----------|
|            |     |       | Mean | S. E. | No. fish | Mean  | S. E. | No. fish | Mean       | S. E. | No. fish | Mean       | S. E. | No. fish |
| 1951       | 0+  | Sept. | —    | —     | —        | 11.9  | 0.107 | 292      | 10.0       | —     | 1        | 13.2       | 0.050 | 523      |
|            |     | Oct.  | 13.7 | 0.473 | 10       | —     | —     | —        | 13.0       | 2.000 | 2        | —          | —     | —        |
| 1950       | 1+  | April | —    | —     | —        | 15.0  | —     | 1        | —          | —     | —        | —          | —     | —        |
|            |     | May   | —    | —     | —        | 17.5  | 0.459 | 25       | 17.1       | 1.101 | 7        | 20.3       | 0.634 | 25       |
|            |     | June  | —    | —     | —        | —     | —     | —        | —          | —     | —        | 19.4       | 0.151 | 181      |
|            |     | Aug.  | 24.0 | 0.423 | 24       | —     | —     | —        | —          | —     | —        | —          | —     | —        |
|            |     | Sept. | —    | —     | —        | 22.4  | 0.194 | 185      | 20.1       | 0.329 | 24       | 26.4       | 0.179 | 198      |
| 1949       | 2+  | Oct.  | 24.4 | 0.104 | 376      | —     | —     | —        | 21.0       | 1.000 | 2        | —          | —     | —        |
|            |     | April | —    | —     | —        | 30.0  | 2.000 | 2        | —          | —     | —        | —          | —     | —        |
|            |     | May   | —    | —     | —        | 29.4  | 0.390 | 56       | —          | —     | —        | 34.6       | 0.404 | 85       |
|            |     | June  | —    | —     | —        | —     | —     | —        | —          | —     | —        | 35.7       | 0.679 | 59       |
|            |     | Aug.  | 37.0 | —     | 1        | —     | —     | —        | —          | —     | —        | —          | —     | —        |
| 1948       | 3+  | Sept. | —    | —     | —        | 36.3  | 0.443 | 67       | 25.1       | 0.348 | 10       | 37.6       | 1.301 | 18       |
|            |     | Oct.  | 39.5 | 0.584 | 13       | —     | —     | —        | 33.7       | 1.308 | 6        | —          | —     | —        |
|            |     | April | —    | —     | —        | 39.8  | 1.103 | 6        | —          | —     | —        | —          | —     | —        |
|            |     | May   | —    | —     | —        | 38.2  | 1.267 | 9        | 35.0       | —     | 1        | 56.0       | 2.000 | 2        |
|            |     | Sept. | —    | —     | —        | 46.9  | 0.986 | 11       | 32.5       | 2.617 | 6        | 59.0       | 1.000 | 2        |
| 1947       | 4+  | Oct.  | 47.7 | 0.689 | 12       | —     | —     | —        | 42.3       | 2.604 | 3        | —          | —     | —        |
|            |     | May   | —    | —     | —        | 51.0  | —     | 1        | —          | —     | —        | —          | —     | —        |
|            |     | Sept. | —    | —     | —        | 51.0  | 3.000 | 2        | 36.3       | 2.729 | 3        | —          | —     | —        |
|            |     | Oct.  | —    | —     | —        | —     | —     | —        | —          | —     | —        | —          | —     | —        |
| 1946       | 5+  | May   | —    | —     | —        | 54.3  | 1.204 | 3        | —          | —     | —        | 65.0       | —     | 1        |
|            |     | Sept. | —    | —     | —        | —     | —     | —        | —          | —     | —        | —          | —     | —        |
|            |     | Oct.  | —    | —     | —        | —     | —     | —        | —          | —     | —        | —          | —     | —        |
|            |     | May   | —    | —     | —        | 56.7  | 0.342 | 3        | —          | —     | —        | 71.0       | —     | 2        |
|            |     | Sept. | —    | —     | —        | 59.5  | 6.500 | 2        | —          | —     | —        | —          | —     | —        |
| 1945       | 6+  | Oct.  | —    | —     | —        | —     | —     | —        | 50.0       | —     | 1        | —          | —     | —        |
|            |     | May   | —    | —     | —        | —     | —     | —        | —          | —     | —        | —          | —     | —        |
|            |     | Sept. | —    | —     | —        | —     | —     | —        | —          | —     | —        | —          | —     | —        |
|            |     | Oct.  | —    | —     | —        | —     | —     | —        | —          | —     | —        | —          | —     | —        |
|            |     | May   | —    | —     | —        | —     | —     | —        | —          | —     | —        | —          | —     | —        |
| 1944       | 7+  | June  | —    | —     | —        | —     | —     | —        | —          | —     | —        | 74.0       | —     | 1        |
|            |     | Sept. | —    | —     | —        | 69.0  | —     | 1        | —          | —     | —        | —          | —     | —        |
|            |     | Oct.  | —    | —     | —        | —     | —     | —        | —          | —     | —        | —          | —     | —        |
|            |     | —     | —    | —     | —        | —     | —     | —        | —          | —     | —        | —          | —     | —        |
|            |     | —     | —    | —     | —        | —     | —     | —        | —          | —     | —        | —          | —     | —        |

Table 9. Landings of three Size Categories of Haddock by Aberdeen Trawlers from Faroe, 1951.

|                  | Hours fishing | Cwts. per 100 hours |        |       | Total |
|------------------|---------------|---------------------|--------|-------|-------|
|                  |               | XL+L                | Medium | Small |       |
| January....      | 7,833         | 46.4                | 36.6   | 25.3  | 108.3 |
| February...      | 8,611         | 51.4                | 22.4   | 12.8  | 86.6  |
| March.....       | 10,458        | 85.4                | 31.3   | 14.8  | 131.6 |
| April.....       | 6,603         | 148.6               | 50.7   | 31.0  | 230.3 |
| May.....         | 8,810         | 50.5                | 36.0   | 46.8  | 133.3 |
| June.....        | 16,337        | 19.7                | 16.5   | 21.1  | 57.3  |
| July.....        | 13,213        | 69.3                | 40.6   | 64.6  | 174.5 |
| August.....      | 11,620        | 55.4                | 32.2   | 43.9  | 131.3 |
| September...     | 7,359         | 72.9                | 27.4   | 47.4  | 147.8 |
| October....      | 3,774         | 50.8                | 26.0   | 43.8  | 120.5 |
| November...      | 3,700         | 50.2                | 26.7   | 30.7  | 107.6 |
| December...      | 3,615         | 49.5                | 27.3   | 44.2  | 121.0 |
| Total.....       | 101,933       |                     |        |       |       |
| Annual Mean..... |               | 59.8                | 30.8   | 35.1  | 125.7 |

that the average landings per 100 hours of extra large and large haddocks were more than twice those attained in the previous two years. Landings of medium and small haddocks on the other hand were correspondingly smaller. This is due to the fact that the larger categories were made up of relatively good broods whereas the smaller categories were made up of relatively poor broods.

R. JONES and W. MAIN.

## References.

- JONES (1951). Ann. Biol., VII, 1950.  
 RUSSELL (1914). Bd. Agric. and Fish. Inv., Ser. II, Sea Fish., Vol. I, pt. I.

Total weight landed

(cwts.).....60,983 31,374 35,758 128,115

XL = Extra large. L = Large.

## Lemon Sole.

During 1951 the landings of lemon soles at Aberdeen by British trawlers from Faroe totalled 15,669 cwts. This total (3,281 cwts. less than that of 1950) was achieved by an increase in the fishing effort in which the number of trips rose by 128 (15 %) and the number of hours fishing by 6,895 (7 %). The average catch per 100 hours fishing for the year fell from 19.5 cwts. in 1950 to 15.0 cwts., thus continuing the progressive decline from 33 cwts. in 1946.

The fishing effort by English trawlers at Faroe has also been rising, from 77,724 hours in 1950 to 97,573 hours in 1951. The total British effort in 1951 exceeded 200,000 hours fishing for the first time since 1937, although still only about two-thirds of the record figure for 1932.

The 1951 average catch per unit of fishing time has fallen below the corresponding average for the year 1938, although still remaining higher than the figures for the years 1934 to 1937. The condition of the lemon sole stocks at Faroe appears, therefore, to be approaching the rather overstrained state of the middle 1930's and unless the fishing effort at Faroe declines appreciably in 1952, the lemon sole stocks will almost certainly suffer a further depletion.

A Scottish research vessel operated fairly continually in Faroese waters from April to October inclusive. In 30<sup>1</sup>/<sub>2</sub> hours trawling in July the "Explorer" caught 275 lemon soles with a 48-foot trawl, while "Scotia", in 74<sup>1</sup>/<sub>2</sub> hours fishing throughout the other months, caught 156 with a 30-foot trawl. The size frequencies and age composition of the 431 fish, only 15 of which were taken in the small-mesh cover, are as given in Table 10.

**Table 10.**

### Size Frequencies.

| Size group . . .  | <26  | 26-30 | 31-35 | 36-40 | 41-45 | 46-50 cm. |
|-------------------|------|-------|-------|-------|-------|-----------|
| No. of fish . . . | 73   | 116   | 148   | 80    | 13    | 1         |
| Percentage . . .  | 17.0 | 26.9  | 34.4  | 18.6  | 3.0   | —         |

### Age Composition.

| Brood. . . . .    | 1950 | 1949 | 1948 | 1947 | 1946 | 1945 | 1944 | 1943 |
|-------------------|------|------|------|------|------|------|------|------|
| No. of fish . . . | —    | 3    | 39   | 69   | 138  | 10   | 15   | 56   |
| Percentage . . .  | —    | 0.7  | 9.1  | 16.0 | 32.0 | 2.3  | 3.5  | 13.0 |

| Brood. . . . .    | 1942 | 1941 | 1940 | 1939 | 1938 | 1937 | 1936 | 1935 |
|-------------------|------|------|------|------|------|------|------|------|
| No. of fish . . . | 8    | 39   | 5    | 29   | 2    | 17   | —    | 1    |
| Percentage . . .  | 1.9  | 9.1  | 1.2  | 6.7  | 0.5  | 4.0  | —    | —    |

The size frequencies show a close resemblance to the corresponding figures for 1950 in that the bulk of the fish fall into the small and medium-sized market categories. Fourteen broods are represented in the age analysis from 1949 to 1935. As in 1950 the 1946 brood again surpasses all others by providing 32 % of the catch numerically. Neither of the younger broods of 1947 and 1948 appear to have survived in any great numbers, so that, having regard also to the comparative failure of the 1945 and 1944 broods, that of 1946 is alone outstanding in a period of relatively weak recruitment. This will undoubtedly result in considerable strain being placed on the lemon sole stocks in the next few years. Of the older broods those of 1943, 1941, 1939 and 1937 continue to outnumber the broods of the remaining years represented in the age analysis. If it were not for the good contribution made to the stocks in each of these four years, the size composition of the fish would reveal considerably fewer large fish with consequently poorer landings.

BENNET B. RAE.

## Halibut.

During 1951, 45 halibut were captured in Faroese waters by Scottish research vessels. Table 11 gives the statistical squares and the months in which captures were made, together with the size and age of the fish. As in previous years, the catch consisted almost entirely of age-groups I to III.

**Table 11. Size and Age of Halibut caught at Faroe by Scottish Research Vessels in 1951.**

| Month | Area                         | No. of Fish | Age-Group | Length in cm.                            |
|-------|------------------------------|-------------|-----------|------------------------------------------|
| April | XX21<br>XX22                 | 1           | ?         | 42 (No otoliths available)               |
|       |                              | 15          | I         | 11                                       |
|       |                              |             | II        | 2.29, 1'30, 1'31, 3'32, 1'33, 3'34       |
|       |                              |             | ?         | 1.48, 1'53, 1'83 (No otoliths available) |
| July  | XX23<br>VV21<br>VV23<br>XX23 | 1           | II        | 33                                       |
|       |                              | 1           | II        | 36                                       |
|       |                              | 1           | III       | 49                                       |
|       |                              | 17          | I         | 1 20                                     |
| Sept. | XX22<br>XX23<br>XX24         |             | II        | 1.32, 1.35, 2.36, 5.37, 2.38, 1.39       |
|       |                              |             | III       | 1'45, 1'49, 1'50, 1.51                   |
|       |                              | 1           | I         | 22                                       |
|       |                              | 1           | II        | 41                                       |
| Oct.  | XX23                         | 1           | II        | 46                                       |
|       |                              | 6           | I         | 1'24, 1'25, 1'26, 1'27, 1'29             |
|       |                              |             | II        | 1 43                                     |

A. D. McINTYRE.

# Cod. Iceland.

## Predictions of qualitative and quantitative Fluctuations.

A short survey of the Icelandic stock of cod during the years 1928—50 has been given previously (Ann. Biol. Vol. VII, 1950). In that paper it was mentioned that the older otolith material had been revised with regard to the so-called spawning zones. The interpretation of the spawning zones<sup>1)</sup> has greatly extended our knowledge of the mature part of the stock and it has also made possible qualitative and quantitative predictions of the spawning stock one year in advance.

The results of the otolith readings for each spawning season are tabulated as shown on Figure 27 for the year 1951. The sums of the

<sup>1)</sup> ROLLEFSEN, G.: The Otoliths of the Cod. (1933). The Spawning Zone in Cod Otoliths and Prognosis of Stock. (1935). Rep. Norw. Fish. and Mar. Invest. 4, 3 and 11.

READ BY: I. ÓSKARSSON

LOCALITY: S. AND SW. COAST  
DATE: JAN.—MAY 1951  
GEAR: LONG-LINE

|            | AGE AT FIRST SPAWNING |      |     |     |      |      |      |      |     |     |     |            |     |      | AGE DISTRIB. |      |      |      |
|------------|-----------------------|------|-----|-----|------|------|------|------|-----|-----|-----|------------|-----|------|--------------|------|------|------|
|            | 4                     | 5    | 6   | 7   | 8    | 9    | 10   | 11   | 12  | 13  | 14  | IM-<br>MAY | 2   | NO.  | %            | NO.  | %    |      |
| AGE GROUPS | 3                     |      |     |     |      |      |      |      |     |     |     |            | 55  |      |              |      |      |      |
|            | 4                     | 2    |     |     |      |      |      |      |     |     |     |            | 69  | 2    | 2.005        | 4    | 0.1  |      |
|            | 5                     |      | 7   |     |      |      |      |      |     |     |     |            | 33  | 11   | 7.02         | 18   | 0.4  |      |
|            | 6                     |      | 8   | 153 |      |      |      |      |     |     |     |            | 6   | 3    | 161          | 4.1  | 164  | 3.7  |
|            | 7                     |      | 1   | 25  | 267  |      |      |      |     |     |     |            | 2   | 14   | 293          | 7.4  | 307  | 6.9  |
|            | 8                     |      |     | 3   | 106  | 439  |      |      |     |     |     |            | 33  | 548  | 13.9         | 581  | 13.2 |      |
|            | 9                     |      |     | 5   | 75   | 846  | 101  |      |     |     |     |            | 168 | 2027 | 51.5         | 2195 | 49.8 |      |
|            | 10                    |      |     | 1   | 6    | 52   | 116  | 76   |     |     |     |            | 35  | 251  | 6.4          | 286  | 6.5  |      |
|            | 11                    |      |     |     | 7    | 18   | 30   | 24   | 6   |     |     |            | 30  | 85   | 2.2          | 115  | 2.6  |      |
|            | 12                    |      |     |     | 2    | 12   | 32   | 34   | 30  | 3   |     |            | 36  | 113  | 2.9          | 149  | 3.4  |      |
|            | 13                    |      |     |     |      | 8    | 14   | 21   | 9   | 8   |     |            | 16  | 60   | 1.5          | 76   | 1.7  |      |
|            | 14                    |      |     |     |      | 2    | 9    | 11   | 16  | 14  | 1   | 1          | 20  | 54   | 1.4          | 74   | 1.7  |      |
|            | 15                    |      |     |     |      | 1    | 10   | 29   | 77  | 67  | 25  | 16         | 5   | 81   | 230          | 5.8  | 311  | 7.1  |
|            | 16                    |      |     |     |      |      | 2    | 9    | 20  | 13  | 15  | 3          |     | 14   | 62           | 1.6  | 76   | 1.7  |
|            | 17                    |      |     |     |      |      |      | 2    | 7   | 5   | 2   | 3          | 1   | 5    | 20           | 0.5  | 25   | 0.6  |
|            | 18                    |      |     |     |      |      |      | 5    | 1   | 3   | 4   | 3          |     | 6    | 16           | 0.4  | 22   | 0.5  |
|            | 19                    |      |     |     |      |      |      |      | 1   |     |     | 2          |     | 1    | 3            | 0.1  | 4    | 0.1  |
|            | 20                    |      |     |     |      |      |      | 1    | 1   |     | 1   |            |     |      | 3            | 0.1  | 3    | 0.07 |
|            | 21                    |      |     |     |      |      |      |      |     |     |     |            |     |      |              |      |      |      |
|            | 22                    |      |     |     |      |      |      |      |     |     |     |            |     | 1    |              |      | 1    | 0.02 |
|            | 2                     |      |     |     |      |      |      |      |     |     |     |            |     |      |              |      | 251  |      |
|            | TOTAL                 | NO.  | 2   | 16  | 187  | 466  | 1397 | 1350 | 277 | 148 | 58  | 28         | 6   | 165  | 476          | 3935 | 4411 |      |
|            | %                     | 0.05 | 0.4 | 4.8 | 11.8 | 35.5 | 34.3 | 7.0  | 3.8 | 1.5 | 0.7 | 0.2        |     |      |              |      |      |      |

### SPAWNING CLASSES

|     | 1    | 2    | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  | 11 | 12   | 13   | 14 | 15 | TOTAL |
|-----|------|------|-----|-----|-----|-----|-----|-----|-----|-----|----|------|------|----|----|-------|
| NO. | 2054 | 1169 | 221 | 125 | 135 | 116 | 69  | 31  | 6   | 7   |    | 1    | 1    |    |    | 3935  |
| %   | 52.2 | 29.7 | 5.6 | 3.2 | 3.4 | 2.9 | 1.8 | 0.8 | 0.2 | 0.2 |    | 0.02 | 0.02 |    |    |       |

Figure 27. Composition of the Icelandic stock of cod in the spawning season 1951.

horizontal rows show the age-groups, the sums of the vertical rows the spawning groups, i.e., fish becoming mature at the same age. The sums of the diagonals give the spawning classes, i.e.: fish becoming mature in the same calendar year.

For a further explanation of the scheme used let us consider the dominant 1942 year-class. Of the 2195 individuals which were taken for age-determinations, the otoliths of 168 could not be read with regard to the spawning zones. Of the remaining 2027, 1101 had no visible spawning zones although they were mature and were therefore spawning for the first time, 846 had one spawning zone and were thus spawning for the second time, 75 were spawning for the third time and 5 for the fourth time.

Looking at the 1936 year-class which is now 15 years old it is seen that there are no recruit spawners and most of the fish are

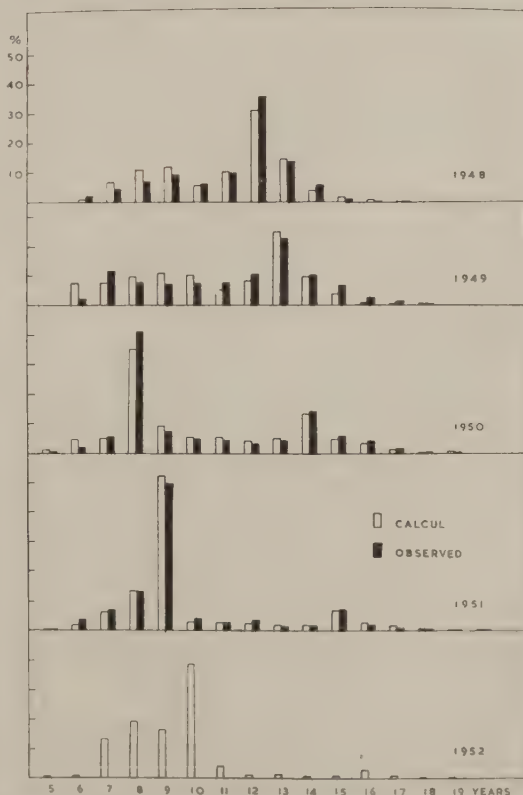


Figure 28. Comparison between the observed and calculated age distributions in the years 1948—52.



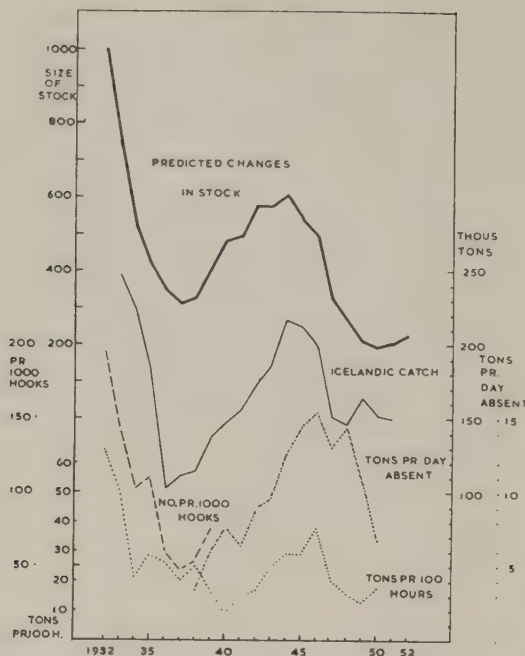


Figure 29. Comparison between the predicted fluctuations in the stock and actual fluctuations in the catch.

spawning for the fifth or the sixth time, one even for the ninth time.

As regards the spawning groups, most of the fish become mature at 8 and 9 years but the age of recruit spawners ranges from 4 to 14 years.

There are 52.2 % recruit spawners belonging to the first spawning class and 29.7 % are spawning for the second time. The average number of first time spawners caught on long-lines is not usually so high (abt. 40 %), but the number fluctuates with the age of the dominant year-classes and can fall down to 20 %.

These spawning schemes form the foundation for our predictions of the spawning stock. The forecast takes into account the rate of mortality (50 %) and the maturity factors which are defined as the proportions of the fish becoming mature in the years  $n$  and  $n + 1$ .

Figure 28 shows the comparison between the observed and calculated age distributions in the years 1948—52. These calculations have been made for the years back to 1931 and the agreement is good in most years.

In Figure 29 the thick line shows the predicted fluctuations in the size of the stock. Assuming the stock to consist of 1000 fishes in 1932, there should be a reduction of 25.2 % in 1933 and the stock should that year consist of 748 fishes. Theoretically there should be a decrease in the stock until 1937 when it should consist of 311 fishes. Thereafter the stock should increase, by 4.8 % in 1938, and keep on increasing until 1944 when the number should amount to 605. After this year there should be a steady decrease until 1950 when the stock should amount to 196 fishes.

If we compare this curve with the actual catch during the same period it will be seen that the correlation is very good. The total amount of cod caught by the Icelanders is in a very close agreement. The catch per unit of effort also agrees fairly well. The broken line, shows the number caught per 1000 hooks in the Vestman Islands; unfortunately this curve ends in 1939. The catch per 100 hours of Scottish trawlers also agrees with the theoretical curve with only few exceptions. The catch per days absence of Icelandic trawlers shows a steady increase until 1946 (the figures for 1948—50 which are based upon the catches of the new Icelandic trawlers are reduced by 25 % to be comparable to the catches of the older type of trawlers).

These results will be discussed in greater detail in a work on the Icelandic stock of cod, now in preparation, but it may be stated here that they confirm in a very convincing manner the results of GUNNAR ROLLEFSEN published about 20 years ago.

JÓN JÓNSSON.

#### Saithe.

#### Remarks on the young Saithe (*Gadus virens*, LINNÉ) off the North Coast of Iceland in 1950-1951.

It is well known that the herring fishery of northern Iceland, which takes place mainly during July-August, has now failed for seven seasons. The seasons of 1950 and 1951 were especially bad. For week after week the purse-seiners were seeking herring and waiting for catches, but mostly in vain, and most of the reduction plants had no herring to process. It was under these circumstances that, in July 1950, the attention of the fishermen was drawn

to the unusually rich occurrence of saithe which appeared in shoals at the surface.

It is true that saithe occurs in the waters perhaps annually, but not usually in vast quantities. As a rule it has been avoided by the fishermen, being of comparatively little value and often difficult to deal with by seines.

In 1950 some vessels, owing to the lack of herring, turned over to catching saithe. This kind of fishery did not prove to be as difficult as had been expected nor so risky to the gear as had been feared. Another surprise was the size of the fish. The shoals were not composed of very small fish such as the 1-group as had been expected from previous experience, but were of much larger and older individuals, as will be mentioned later.

The total quantity of saithe, taken by purse-seine off the north coast, amounted to about 10,000 tons (wet weight) in 1950 and 1,891 tons in 1951. It is pointed out for comparison that the total catches of saithe, taken by Icelanders by means of "normal" gears, long-line and trawl, has been as follows during recent years:

|                                |                   |
|--------------------------------|-------------------|
| 1946: 19,517 tons (wet weight) |                   |
| 1947: 31,688 -                 | 1949: 39,321 tons |
| 1948: 66,362 -                 | 1950: 15,172 -    |

The purse-seine catches in 1950—1951 were almost exclusively taken off the central part of the north coast. Another interesting feature is the steep decline in purse-seine yields, by more than 80 %, from 1950 to 1951. At least two factors have contributed to this development; as will be shown later, the saithe in 1951 were, on the whole, considerably larger than in 1950 and therefore more difficult to catch and the catching in turn involved greater risk to the seines; in August 1951 practically all the fishing fleet was located off the easternmost part of the north coast and off the east coast where herring shoals had been recorded — only a few vessels were operating off the central part of the north coast where the saithe were found.

The saithe, at least in 1950, proved to be easy to process, even easier than the herring. The quality was good, the liver contributing about 11 % of the total weight of the fish and the oil content of the liver being about 70 %.

In 1950, 1668 saithes were measured and 300 examined as to age in the herring laboratory of the "University Research Institute" in Siglufjord. The age was read by means of

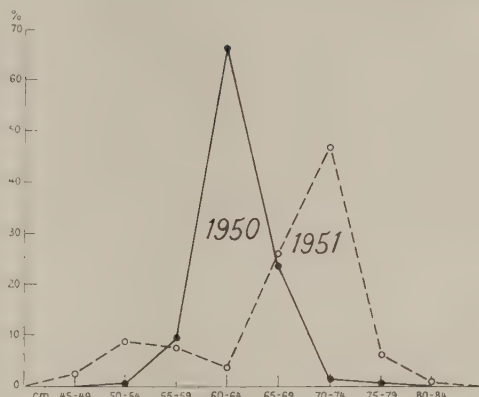


Figure 30.

the otoliths. In 1951 about 5000 were measured and 400 age analyses were made.

In Figure 30 the size distribution of the fish in both seasons is shown. In 1950 there is one peak at 60—64 cm., but in 1951 there are two, one at 50—54 cm. and the other at 70—74 cm. These three peaks correspond to three different age-classes of 4, 5 and 6-year-old fish.

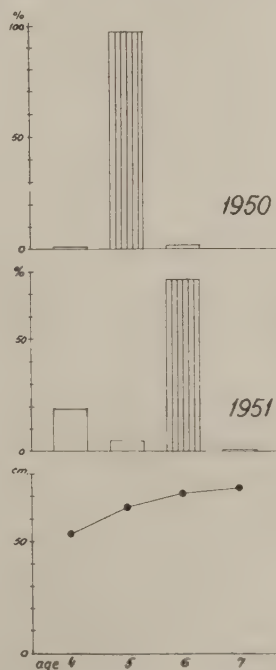


Figure 31. The age composition of saithe caught in purse-seine off north Iceland in 1950—51, and the average size of the age-groups.

A survey of the age composition is given in Figure 31. In 1950 the 5-year-old fish (the year-class from 1945) were entirely predominant, making up 97 % of the total yield. The only other age-groups on record were 4 and 6-year-old fish contributing 2 and 1 % respectively. The average size of the 5-year-olds was 62.50 cm. on 16. August and 63.71 cm. on 23. August, corresponding to an increment in length of 1.2 cm. during a week.

In 1951 we found the same year-class as in the previous year, now 6 years old, to be dominant. It contributed 75.8 % of the total yield.

The average length of this group was then (10.—13. August) 70.98 cm., representing an annual increment, from 5th to 6th year, of about 8 cm. In 1951 another year-class also appeared in the catches, viz.: that of 1947 (4-year-old fish). In some of the catches it was absolutely predominant, in others it was mixed up with the principal dominant, and in still others it was almost absent. The following figures, which represent three "shots", will illustrate this:

| Locality         | Grims. sund | Grims. sund | Málmeý   |
|------------------|-------------|-------------|----------|
| Date             | 9. Aug.     | 10. Aug.    | 13. Aug. |
| Yield pr. "Shot" | 575 hl.     | 210 hl.     | 1010 hl. |
|                  | %           | %           | %        |
| 4-year olds..... | 6.5         | 54.0        | 8.0      |
| 5 - - - - -      | 4.0         | 6.0         | 5.0      |
| 6 - - - - -      | 88.5        | 39.0        | 87.0     |
| 7 - - - - -      | 1.0         | 1.0         | —        |
| Total.....       | 100.0 %     | 100.0 %     | 100.0 %  |

The average length of the 4-year-olds was 53.52 cm. which, when compared with the average length of the 5-year-olds in the previous year, indicates a growth of 10 cm. in the 5th year.

The age compositions of the total yields of 1950 and 1951, according to our investigations, are demonstrated in Figure 31. The diagram at the bottom of the figure shows the average size of the fish according to age and also the annual growth from the 4th to the 7th year.

In August 1950 20 stomachs were analysed as to food content, the results being as follows:

|        |        |        |                                     |
|--------|--------|--------|-------------------------------------|
| No. 1. | Volume | 55 cm. | cod larvae, 5—6 cm. long.           |
| - 2.   | —      | 65 -   | euphausid larvae.                   |
| - 3.   | —      | 30 -   | cod larvae.                         |
| - 4.   | —      | 20 -   | remnants of cod larvae.             |
| - 5.   | —      | 20 -   | remn. of cod and euphausid larvae   |
| - 6.   | —      | —      | traces of cod and euphausid larvae. |
| - 7.   | —      | —      | traces of cod and euphausid larvae. |

|        |   |        |                                   |
|--------|---|--------|-----------------------------------|
| No. 8. | — | 10 cm. | remn. of euphausid larvae.        |
| - 9.   | — | 20 -   | remn. of cod and euphausid larvae |
| - 10.  | — | —      | traces of euphausid larvae.       |
| - 11.  | — | 10 cm. | remn. of euphausid larvae.        |
| - 12.  | — | —      | traces of euphausid larvae.       |
| - 13.  | — | 15 cm. | remn. of euphausid larvae.        |
| - 14.  | — | —      | traces of euphausid larvae.       |
| - 15.  | — | 5 cm.  | euphausid larvae.                 |
| - 16.  | — | 10 -   | remnants of cod larvae.           |
| - 17.  | — | 10 -   | — - - -                           |
| - 18.  | — | 5 -    | — - - -                           |
| - 19.  | — | 15 -   | — - cod and euphausid larvae.     |
| - 20.  | — | 10 -   | — - cod and euphausid larvae.     |

Several other stomach samples were examined but not analysed; the contents were always the same—larvae of cod and euphausids, the cod larvae contributing the largest volume. In 1951, however, cod larvae seemed to be entirely absent.

It seems evident that the biotope in which the saithe occurs is quite different from that of the north coast herring. In the case of the former we have water of relatively high temperature, 8°C. or more at the surface; we there meet with cod larvae from the year's brood in the south, immature saithe from coastal waters, euphausid larvae and so on. In the case of the latter the surface temperatures are lower, 7—8°C. or less; this is the habitat of relatively old *Calanus* (copepodite stage VI or even adult) and the north coast herring. The first biotope is of neritic, the second of oceanic origin.

ÁRNI FRÍÐRIKSSON.

## Lemon Sole.

During the visit of the "Scotia" to Icelandic waters, from 22. to 28. August 1951, 14<sup>1</sup>/<sub>2</sub> hours trawling was carried out with the 30-foot otter trawl between Vestrahorn and Faxa Bay. Catches of flatfishes were far poorer than in September 1950.

The total of 35 lemon soles caught in 1951 compares unfavourably with 122 fish from 9 hours fishing in 1950. The difference in the two years was particularly marked at the two standard stations in the southern section of Faxa Bay where two lemon soles were taken on this occasion as compared with 93 a year ago. The best catch in 1951 consisted of 14 lemon soles from a position west of Reykjanes. The 35 fish ranged in size from 22 to 42 cm. and included 12 different broods. The age



analysis from scale samples gave the following results:—

|             |      |    |    |    |    |    |    |    |    |    |    |    |    |    |
|-------------|------|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Brood       | 1947 | 46 | 45 | 44 | 43 | 42 | 41 | 40 | 39 | 38 | 37 | 36 | 35 | 34 |
| No. of fish | 3    | 4  | 1  |    | 4  | 7  | 7  | 1  | 3  | 1  | 1  | 2  | -  | 1  |

The majority of the fish appeared to have been caught while spawning, a few were in the spent condition and two only, both group IV females, were immature.

B. B. RAE.

### Plaice.

The numbers of plaice taken at the standard international stations in Faxa Bay inside and outside territorial waters were 2 and 17 respectively. These figures are in sharp contrast to the 299 and 113 fish caught on the same grounds last year. In 1951, 22 plaice were taken at a third position further north. Details of the size and age of these 41 fish are given in the following figures:—

|                   |      |       |       |       |       |       |      |
|-------------------|------|-------|-------|-------|-------|-------|------|
| Brood             | 1949 | 1948  | 1947  | 1946  | 1945  | 1944  | 1943 |
| No. of fish . . . | 1    | 5     | 13    | 6     | 12    | 3     | 1    |
| Size range cm..   | 26   | 19-34 | 25-32 | 27-35 | 21-39 | 33-40 | 37   |
| Mean size cm..    | 26.0 | 28.8  | 29.2  | 30.8  | 32.3  | 35.7  | 37.0 |

Small though these numbers are they nevertheless help to confirm the previous year's analysis which showed the most numerous broods in Faxa Bay to be those of 1947 and 1945.

B. B. RAE and J. M. LAMONT.

### Halibut.

Six halibut were taken in Faxa Bay with the "Scotia" trawl; 5 of these at the extra-territorial standard station and one at another position to the north of this point. The fish, ranging in size from 29 to 39 cm. were all members of group II. This species was not represented in the catches along the south coast of Iceland.

A. D. McINTYRE.

### On the Icelandic Fishery in the Denmark Strait in 1950.

After the depletion of the stock of halibut in Icelandic waters during the first quarter of this century, halibut has not played any important role in the Icelanders' fisheries, but

it has, owing to its high market value, contributed to the catches as a valuable by-product.

During recent years the total quantity caught by Icelanders has been as follows:—

|       |                       |
|-------|-----------------------|
| 1946: | 892 tons (wet weight) |
| 1947: | 980 -                 |
| 1948: | 1777 -                |
| 1949: | 1855 -                |
| 1950: | 839 -                 |
| 1951: | 1716 -                |

The halibut had not been the subject for any special fishery of importance until 1950 and 1951, when some line-fishing vessels made trips for it to the edge of the continental shelf west of Breida Bay and Faxa Bay.

In 1950 some material was collected for the age-determination of the fish caught. 772 fish were measured and otoliths were taken for age readings. One of the authors (SIGURÐSSON) has made the age readings and the other (FRÍÐRIKSSON) has compiled the material. Unfortunately it was not possible to record sex and net weight as the fish were gutted on board the vessels. The material investigated was from catches taken during the period 17. May—17. June 1950 in the area 115—135 n.m. NNW.-NW. of Akranes (Faxa Bay). Records of the size and age are given in Table 12. The size ranged from less than 70 cm. (two fish) to more than 200 cm. (two fish). Nearly three quarters of the catches (73.2 %) ranged from 110—150 cm. and 43.2 % from 120—140 cm. The average length was 136.63 cm. and the average weight may be estimated as well over 20 kg<sup>1</sup>). The distribution of size in the different age-groups is also shown in the table.

The age distribution of the stock is demonstrated in Figure 32. There were at least 16 year-classes from 6 to over 20 years of age. The dominant year-class was that of 12-year-old fish which made up more than a quarter (27.4 %); the second strongest year-class was that of 1939 (11 years old). Other relatively strong year-classes were those from 1937, 1936 and 1935, 13, 14 and 15 years old respectively. Altogether fish aged from 11 to 14 years made up nearly three quarters (74.3 %) of the total

<sup>1</sup>) The halibut caught by Scottish line-fishing vessels west of Iceland in 1950 seem to have been somewhat more uniform in size, as they only ranged between 95 and 180 cm. (204 fish). A. D. McINTYRE, Ann. Biol., Vol. VII, p. 37.

Table 12. Age and Size of Halibut landed at Akranes in 1950.

| cm./Age | 6    | 7    | 8    | 9     | 10    | 11    | 12    | 13    | 14    | 15    | 16    | 17    | 18    | 19    | 20    | 20 ?  | T   | %     |
|---------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----|-------|
| > 200   | —    | —    | —    | —     | —     | —     | —     | —     | —     | —     | —     | —     | —     | 1     | —     | 1     | 2   | 0.3   |
| 190-199 | —    | —    | —    | —     | —     | —     | —     | —     | —     | 1     | 1     | —     | 5     | —     | 1     | 2     | 10  | 1.3   |
| 180-189 | —    | —    | —    | —     | —     | —     | —     | —     | 2     | 1     | 1     | 3     | —     | 1     | —     | 1     | 9   | 1.2   |
| 170-179 | —    | —    | —    | —     | —     | —     | 4     | 3     | 5     | 3     | 2     | 2     | 1     | —     | —     | —     | 20  | 2.6   |
| 160-169 | —    | —    | —    | —     | —     | 3     | 11    | 6     | 8     | 6     | 4     | —     | —     | 1     | —     | 7     | 46  | 5.9   |
| 150-159 | —    | —    | —    | —     | —     | 6     | 11    | 15    | 16    | 5     | 7     | 2     | 4     | 1     | —     | —     | 67  | 8.7   |
| 140-149 | —    | —    | —    | —     | 1     | 12    | 36    | 14    | 17    | 13    | 4     | 1     | 2     | —     | —     | —     | 100 | 12.9  |
| 130-139 | —    | —    | —    | —     | 4     | 26    | 45    | 38    | 21    | 14    | 6     | 1     | —     | —     | 1     | 2     | 158 | 20.5  |
| 120-129 | —    | —    | —    | 1     | 12    | 46    | 58    | 23    | 18    | 11    | —     | 1     | —     | —     | —     | 3     | 173 | 22.4  |
| 110-119 | —    | —    | —    | 6     | 12    | 51    | 42    | 17    | 4     | 2     | —     | —     | —     | —     | —     | 1     | 135 | 17.5  |
| 100-109 | —    | —    | 3    | 7     | 9     | 6     | 6     | 1     | —     | —     | —     | —     | —     | —     | —     | 1     | 33  | 4.3   |
| 90-99   | —    | —    | 1    | 1     | 2     | 2     | —     | —     | —     | —     | —     | —     | —     | —     | —     | —     | 6   | 0.8   |
| 80-89   | 1    | 2    | —    | 3     | —     | —     | —     | —     | —     | —     | —     | —     | —     | —     | —     | —     | 6   | 0.8   |
| 70-79   | 2    | 3    | —    | —     | —     | —     | —     | —     | —     | —     | —     | —     | —     | —     | —     | —     | 5   | 0.6   |
| 60-69   | 1    | —    | 1    | —     | —     | —     | —     | —     | —     | —     | —     | —     | —     | —     | —     | —     | 2   | 0.3   |
| N.....  | 4    | 5    | 5    | 18    | 40    | 152   | 213   | 117   | 91    | 56    | 25    | 10    | 12    | 4     | 2     | 2     | 772 | —     |
| %.....  | 0.5  | 0.6  | 0.6  | 2.3   | 5.2   | 19.7  | 27.6  | 15.2  | 11.8  | 7.3   | 3.2   | 1.3   | 1.5   | 0.5   | 0.3   | 0.3   | 2.1 | 100.0 |
| M.....  | 75.5 | 79.6 | 94.4 | 104.2 | 115.7 | 125.0 | 132.1 | 135.8 | 142.7 | 143.5 | 154.2 | 160.8 | 170.5 | 179.0 | 167.5 | 194.5 | —   | 136.6 |

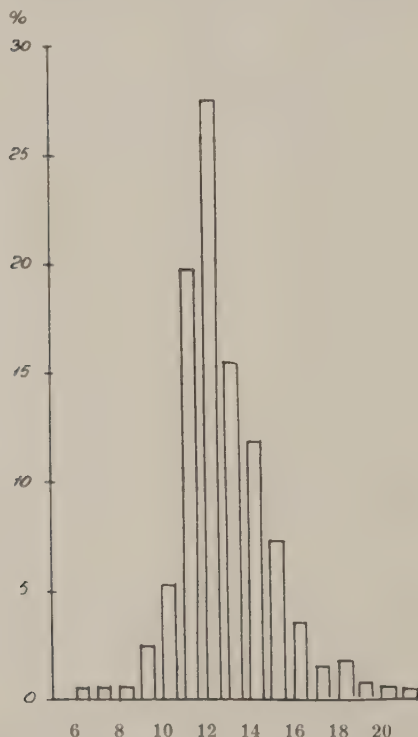


Figure 32. The age distribution of halibut landed in Akranes in 1950.

catch. The fishery especially for halibut has therefore been based almost entirely on these 4 or 5 year-classes without which it would not have been profitable.

It is interesting to note that in the Faxa Bay,

where the most important nursery grounds for halibut are situated, there was a relatively large number of young halibut (1—3 years old) in the years just before the war. According to JESPERSEN<sup>1</sup>), on an average 8—9 halibut were caught per trawling hour by 50' otter-trawl in the southern part of the bay in 1930. In 1935 the comparative number was 3—4, in 1938 it was 8 and in 1939 it was 45—46 fish. This might mean that the relative abundance of halibut on deep water grounds during recent years was a temporary one, originating from some few good year-classes in the late thirties.

A. SIGURÐSSON & ÁRNI FRÍÐRIKSSON.

### Redfish.

#### Notes on the *Sebastes marinus* (LINNÉ) and the Icelandic Redfish Fishery west of Iceland.

The redfish fishery has been of increasing importance in Iceland during recent years. There are two main fishing grounds in offshore waters, one off the west coast and the other to the south-east. The greater part of the catches is processed to oil and meal, but redfish is also landed in iced condition in European ports. During the last two years redfish fillets have been quickfrozen and packed for the U. S. A. market. The redfish is taken exclusively by large trawlers and in some months (for instance Nov.-Dec. 1950) a considerable part of the Icelandic trawler fleet (25—26 trawlers) has been engaged in this fishery.

<sup>1</sup>) Rapp. et Proc.-Verb., Vol. 120, pp. 36—38. 1948.

Table 13. Market Analyses of Trawl Catches from the Redfish Grounds off west Iceland in 1951 (%).

| Month              | No. of trips | Redfish | Cod  | Saithe | Haddock | Ling <sup>1)</sup> | Halibut | Catfish | Total yields (Tons) |
|--------------------|--------------|---------|------|--------|---------|--------------------|---------|---------|---------------------|
| January.....       | 1            | 69.5    | 15.8 | 14.6   | —       | —                  | 0.1     | —       | 281.9               |
| February.....      | —            | —       | —    | —      | —       | —                  | —       | —       | —                   |
| March.....         | 3            | 79.5    | 12.3 | 6.5    | 1.4     | —                  | 0.3     | —       | 607.2               |
| April.....         | 3            | 86.9    | 3.5  | 9.5    | —       | —                  | 0.1     | —       | 737.9               |
| May.....           | 4            | 93.4    | 2.3  | 4.2    | —       | —                  | 0.1     | —       | 1380.8              |
| June.....          | 3            | 97.6    | 0.1  | 2.2    | —       | —                  | 0.1     | —       | 836.8               |
| July.....          | 3            | 87.4    | 0.1  | 12.4   | —       | —                  | 0.1     | —       | 815.3               |
| August.....        | 2            | 76.4    | 3.3  | 19.8   | 0.2     | —                  | 0.3     | —       | 548.2               |
| September.....     | —            | —       | —    | —      | —       | —                  | —       | —       | —                   |
| October.....       | 1            | 52.5    | 29.9 | 14.3   | —       | 2.7                | 0.2     | 0.4     | 254.0               |
| November.....      | 2            | 93.0    | 3.8  | 2.3    | +       | 0.6                | 0.1     | 0.2     | 502.1               |
| December.....      | —            | —       | —    | —      | —       | —                  | —       | —       | —                   |
| Aver. per month .  | 22           | 81.7    | 7.9  | 9.5    | 0.2     | 0.4                | 0.2     | 0.1     | 5964.2              |
| Aver. per trip.... | —            | 86.4    | 4.9  | 8.2    | 0.2     | 0.2                | 0.1     | +       | —                   |

<sup>1)</sup> Mostly *Molva byrkclange*.

The quantity of redfish taken by Icelandic trawlers during recent years has been as follows (wet weight):—

|      |            |      |             |
|------|------------|------|-------------|
| 1946 | 5,168 tons | 1949 | 32,662 tons |
| 1947 | 9,980 -    | 1950 | 71,388 -    |
| 1948 | 25,120 -   |      |             |

Final figures for 1951 are not yet available.

Market analyses were made in Akranes (SW.) on all catches from one trawler throughout the year 1951. The trawler made 22 trips to the redfish grounds west of Iceland and landed altogether 5964.2 tons of fish (see Table 13). Landings were made in all months except February, September and December.

In Table 13 records are given of the composition of the catch from month to month, as well as of the total catch. The highest catches per trip were taken in May (345 tons on an average) and the lowest ones in March (202 tons). The average composition of catches both per month and per trip is given at the bottom of the table. The first series of figures gives an idea of the seasonal changes whereas the "averages per trip" indicate the relative yield of each species in the total quantity landed throughout the whole year.

Only 7 species are recorded in the table, all others being practically absent. The redfish, contributing 86.4 % to the total quantity landed during the year, made up by far the major part of the catches. Saithe contributed 8.2 % and cod 4.9 %; the 5 remaining species were of relatively insignificant importance as they together contributed only 0.5 %.

The relative abundance from month to month of the three principal species is demonstrated in Figure 33. The proportion of redfish in the catches ranged between 52.5 % (Oct.) and 97.6 %. The diagram shows two peaks, one in June, the other in November. The cod and saithe on the other hand were most numerous during spring and in the late summer and autumn; the spring peak might be accounted for by fish being on their way to the spawning grounds in coastal waters off the south and south-west coasts. Halibut occurred in the catches in small quantities throughout the year, whereas ling and catfish were only met with in October and November. It is also interesting to note that haddock were recorded on those deep water banks (mostly 400–500 m.).

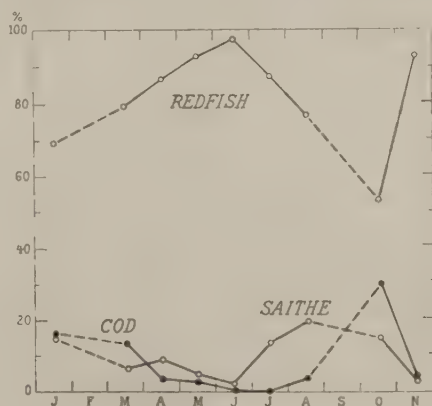


Figure 33. Percentage contribution of the three main species of fish in trawl catches on the redfish grounds west of Iceland in 1951.



**Table 14. Survey of the Size of the Redfish (%).**

| cm.           | 1950          | 1951             |               |
|---------------|---------------|------------------|---------------|
|               | Akranes, Nov. | Siglufjord, Aug. | Akranes, Nov. |
| > 50 . . . .  | 9.5           | 9.5              | 2.8           |
| 45-49 . . . . | 31.0          | 26.8             | 19.3          |
| 40-44 . . . . | 41.0          | 49.0             | 55.3          |
| < 39 . . . .  | 18.5          | 14.7             | 22.6          |
| Total . . . . | 100.0         | 100.0            | 100.00        |

Table 14 is based on 2000 measurements in Akranes Nov. 1950, 2000 in Siglufjord (from the same grounds) Aug. 1951 and 2000 in Akranes Nov. 1951. The fish measured have been divided into four size categories for purposes of clearer comparison. It is evident that the size of fish was decreasing although this does not appear clearly from a comparison between just the first and second columns of the table. The percentages of large fish in Nov. 1950 and in Aug. 1951 were the same and there were relatively fewer small fish in Aug. 1951 than in Nov. 1950. But the percentage of fish more than 44 cm. long was 10.5 % in Nov. 1950 and only 36.3 % in Aug. 1951. In other words, in Aug. 1951 the size range of the fish was less than in Nov. 1950, but the fish were on the whole smaller. Comparing the last column with any of the others, the trend is quite clear. There were relatively much fewer large fish and many more small ones in Nov. 1951. This is illustrated on Figure 34 where the first (Nov. 1950) and the last column (Nov. 1951) of the table are compared and the deviations are shown. If we further consider that in the years 1936-38 about 50 % of the redfish on the grounds were 45 cm. or more, as compared with 40 % in Nov. 1950 and 22 % in Nov. 1951, it becomes

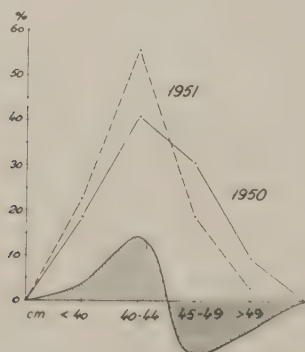


Figure 34. Size distribution of redfish landed in Akranes, November 1950—November 1951. Deviation 1951—1950.

clear that we are dealing with a development towards smaller fish in the stock.

The decrease in the size of the redfish may be due either to recruitment of young fish or to the influence of fishing. If the first alternative was the case, the stock would be increasing, which in turn would mean better yields per unit of effort. There is however no evidence that this is happening; redfish are not more numerous now than they were last year or than they were in the late thirties,—on the contrary, a successful trip requires now longer time and more effort than it did earlier.

We must conclude that the fisheries are responsible for the decreased size of the redfish. This does not necessarily mean that the stock is already overfished. But if the size of the fish continues to decrease, which means an increased rate of mortality and consequently a smaller stock, much will depend on the size of the stock at which an equilibrium is reached: if the yields are then still profitable there is the danger that an increased effort will deplete the stock to a lower equilibrium level which will give no profit to the fisheries. This can be avoided if adequate measures are taken in good time.

ARNI FRIBRIKSSON.

## Greenland.

### Eggs and Larvae.

#### Eggs and Larvae of Cod in 1950.

Hauls with a 1-m. stramin net have been taken from 20. April to 5. June in Godthåb fjord, Ameralik, Amerdlok and Ikertok fjords, over Fyllas Bank, Lille Hellefiske Bank, and Store Hellefiske Bank and at the entrance to Disko Bay. The catches of eggs and larvae per  $\frac{1}{2}$  h. haul are given on the chart on p. 49. It will be seen that the eggs were abundant in the innermost part of Godthåb fjord (Kapisigdlit) where there is a spawning place. Good amounts of cod eggs were also taken on the middle and on the slope of Fyllas Bank, especially on the slope where 566 cod eggs were taken.

On Lille Hellefiske Bank  $65^{\circ}51'N$ .  $54^{\circ}12'W$ . the number of eggs taken 27. May was 384 and on the same date 40 eggs were taken at  $66^{\circ}32'N$ .  $54^{\circ}34'W$ .

On two stations over the southern part of Store Hellefiske Bank and in the Amerdlok



Number of eggs above, of larvae below line.  
●, eggs and larvae; ○, eggs only; x, negative.

and Ikertok fjords no eggs were taken while a single egg was taken 5. June at the entrance to Disko Bay. Cod larvae were taken at one station in Godthåb fjord (42 specimens) and between the coast and Fyllas Bank (8 specimens). On the middle of Fyllas Bank only one larva was caught, but on the slope of Fyllas Bank 99 cod larvae were taken with the stramin net. The numbers of both eggs and larvae were largest in the innermost part of Godthåb fjord and on the slope of Fyllas Bank, this tends to show that a spawning concentration occurs off Fyllas Bank. The spawning ground at Kapisigdlit in Godthåb fjord has been known since 1925. No spawning seems to take place north of 66° 30' N.

When "Dana" operated from 1. to 23. July 1950 in West Greenland waters, all cod eggs were hatched and only larvae were found scattered over the whole Davis Strait to 67° 30' N., predominantly on Fyllas Bank, Lille Hellefiske Bank and the southern part of Store Hellefiske Bank. The largest number of larvae (198) was taken with a 2-m. stramin net (Ann. Biol. 1950, pp. 39 and 40) on Lille Hellefiske Bank. The cod fry were found about 60 miles north of the northernmost catch of cod fry taken by "Adolf Jensen". This indicates that the fry have drifted with the north-going current and have concentrated more on the Lille Hellefiske Bank than on Fyllas Bank.

P. M. HANSEN.

Table 15. Age Analyses 1950.

| District       | Umanak      | Disko                  | Egedesminde           | Holsteinsborg | Sukkertoppen | Godthåb  | Frederikshåb | Fyllas Bank | Julianehåb |
|----------------|-------------|------------------------|-----------------------|---------------|--------------|----------|--------------|-------------|------------|
| Year-<br>Class | Age-<br>Gr. | Jakobshavn<br>Number % | Claushavn<br>Number % | Number %      | Number %     | Number % | Number %     | Number %    | Number %   |
| 1946 IV        | —           | —                      | 4 0.4                 | 10 1.4        | 1 0.2        | 2 0.7    | —            | 6 7.4       | 22 1.4     |
| 1945 V         | 5           | 0.6                    | 58 5.4                | 86 12.4       | 45 7.8       | 2 0.7    | 4 2.0        | 27 33.3     | 201 12.9   |
| 1944 VI        | 20          | 2.4                    | 107 9.9               | 125 18.0      | 18 3.1       | 11 3.6   | 20 10.0      | 8 9.9       | 119 7.6    |
| 1943 VII       | 36          | 4.3                    | 168 15.6              | 129 18.6      | 17 3.0       | 7 2.3    | 42 21.0      | 5 6.2       | 98 6.3     |
| 1942 VIII      | 149         | 17.6                   | 349 32.3              | 198 88.5      | 88 15.3      | 14 4.5   | 57 23.5      | 18 22.2     | 150 9.5    |
| 1941 IX        | 52          | 6.1                    | 114 10.6              | 39 5.6        | 53 9.2       | 9 3.0    | 18 9.0       | —           | 43 2.7     |
| 1940 X         | 54          | 6.4                    | 58 5.4                | 11 1.6        | 33 5.7       | 42 13.9  | 23 11.5      | 3 3.7       | 43 2.7     |
| 1939 XI        | 33          | 3.9                    | 41 3.8                | 29 4.2        | 57 9.9       | 25 8.3   | 15 7.5       | 1 1.2       | 64 4.1     |
| 1938 XII       | 13          | 1.5                    | 14 1.3                | 8 1.2         | 30 5.2       | 47 15.5  | 7 3.5        | 5 6.2       | 59 3.8     |
| 1937 XIII      | 16          | 1.9                    | 8 0.7                 | 5 0.7         | 39 6.8       | 34 11.2  | 5 2.5        | 2 2.5       | 128 8.2    |
| 1936 XIV       | 130         | 15.3                   | 61 5.7                | 25 3.6        | 72 12.5      | 37 12.2  | 2 1.0        | 1 1.2       | 184 11.8   |
| 1935 XV        | 90          | 10.6                   | 25 2.3                | 5 0.7         | 39 6.8       | 32 10.6  | 3 1.5        | 1 1.2       | 225 14.2   |
| 1934 XVI       | 210         | 24.8                   | 49 4.5                | 22 3.2        | 57 9.9       | 27 8.9   | 4 2.0        | 4 4.9       | 128 8.2    |
| 1933 XVII      | 19          | 2.2                    | 12 1.1                | 1 0.1         | 15 2.6       | 11 3.6   | —            | —           | 59 3.8     |
| 1932 XVIII     | 15          | 1.8                    | 4 0.4                 | 1 0.1         | 6 1.0        | 2 0.7    | —            | —           | 28 1.8     |
| 1931 XIX       | 4           | 0.5                    | 4 0.4                 | —             | 3 0.5        | 1 0.3    | —            | —           | 4 0.3      |
| 1930 XX        | —           | —                      | 2 0.2                 | —             | 1 0.2        | —        | —            | —           | 5 0.3      |
| 1929 XXI       | —           | —                      | —                     | 1 0.1         | 1 0.2        | —        | —            | —           | 4 0.3      |
| 1928 XXII      | 1           | 0.1                    | 1 0.1                 | —             | —            | —        | —            | —           | 1 0.1      |
|                |             | 847                    | 1079                  | 695           | 575          | 303      | 200          | 81          | 1565       |

Total..... 5345

Table 16. Average Lengths of different Age-Groups of Greenland Cod, 1950.

| Districts:      | Jacobshavn      | Off          | Egedes-      | Holsteins-   | Sukker-      | Godthåb      | Frederiks-   | Julianehåb   |
|-----------------|-----------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Position:       | 69°12'51'00"    | 69°30'55'00" | 68°40'52'50" | 66°55'53'40" | 65°25'52'50" | 64°10'51'45" | 62°00'49'45" | 60°40'46'05" |
| Age-Gr.         | N <sup>1)</sup> | M            | N            | M            | N            | M            | N            | M            |
| Year-Cl.        | N               | M            | N            | M            | N            | M            | N            | M            |
| 1948... +0 3/4  | —               | —            | —            | —            | —            | 10 25.2      | —            | —            |
| II... +0 3/4    | —               | —            | —            | —            | —            | 9 23.3       | —            | —            |
| 1947... 3/4     | —               | —            | —            | —            | 7 30.7       | 48 33.4      | —            | 5 32.6       |
| III... +0 3/4   | —               | —            | —            | —            | 5 33.6       | 60 33.4      | —            | 5 34.6       |
| 1946... +0 3/4  | —               | —            | —            | 3 47.0       | 15 42.3      | 5 38.6       | —            | 9 40.0       |
| IV... +0 3/4    | —               | —            | —            | 1 45.0       | 19 43.1      | 6 42.8       | 2 36.5       | 13 37.9      |
| 1945... +0 3/4  | —               | —            | —            | 21 49.3      | 104 53.8     | 22 56.3      | 1 64.0       | 1 58.0       |
| V... +0 3/4     | —               | —            | —            | 41 55.8      | 105 53.6     | 30 56.4      | 1 55.0       | 3 55.7       |
| 1944... +0 3/4  | —               | —            | —            | 62 63.0      | 54 61.4      | 6 60.3       | 6 53.7       | 10 60.5      |
| VI... +0 3/4    | —               | —            | —            | 67 63.1      | 82 64.0      | 16 64.1      | 5 55.8       | 10 61.5      |
| 1943... +0 3/4  | 1 64.0          | —            | —            | 80 66.9      | 55 66.5      | 7 68.1       | 3 63.7       | 21 63.2      |
| VII... +0 3/4   | 2 69.5          | —            | —            | 122 69.0     | 79 64.5      | 11 67.3      | 4 60.0       | 21 64.6      |
| 1942... +0 3/4  | 7 70.3          | —            | —            | 186 73.6     | 63 75.0      | 45 72.8      | 7 68.3       | 13 71.7      |
| VIII... +0 3/4  | 21 75.5         | 4 71.1       | 268 75.3     | 135 78.5     | 53 75.5      | 7 68.9       | 44 71.1      | 92 72.0      |
| 1941... +0 3/4  | 2 77.5          | 4 77.0       | 74 75.9      | 12 78.6      | 25 69.8      | 5 65.0       | 6 69.8       | 11 75.2      |
| IX... +0 3/4    | 8 74.8          | 2 74.0       | 73 77.0      | 27 82.9      | 31 75.1      | 4 70.0       | 12 75.9      | 32 78.3      |
| 1940... +0 3/4  | 8 76.1          | 3 78.3       | 31 77.2      | 5 81.8       | 11 74.7      | 22 65.9      | 10 71.8      | 14 77.3      |
| X... +0 3/4     | 9 75.8          | 4 79.0       | 47 80.0      | 6 83.0       | 23 74.5      | 20 71.6      | 13 75.5      | 29 79.8      |
| 1939... +0 3/4  | 6 76.0          | —            | 22 79.1      | 14 84.4      | 24 83.6      | 7 67.1       | 8 75.1       | 27 80.0      |
| XI... +0 3/4    | 8 80.6          | 3 84.0       | 27 80.7      | 15 89.6      | 31 78.4      | 18 72.6      | 7 78.7       | 37 81.3      |
| 1938... +0 3/4  | 2 79.0          | 3 83.7       | 5 82.0       | —            | 18 77.7      | 18 69.9      | 1 78.0       | 23 78.4      |
| XII... +0 3/4   | 2 78.0          | —            | 13 82.7      | 8 88.3       | 12 95.0      | 29 76.0      | 6 82.8       | 36 82.4      |
| 1937... +0 3/4  | —               | —            | 4 84.7       | 3 84.7       | 18 73.4      | 15 75.2      | 3 73.3       | 49 81.1      |
| XIII... +0 3/4  | 4 82.3          | 1 87.0       | 13 78.2      | 2 81.3       | 21 80.4      | 19 74.9      | 2 71.0       | 79 83.3      |
| 1936... +0 3/4  | 17 79.2         | 18 83.1      | 51 82.2      | 10 84.6      | 44 77.5      | 15 71.2      | —            | 65 81.4      |
| XIV... +0 3/4   | 17 82.7         | 16 84.5      | 51 83.6      | 15 87.7      | 30 79.2      | 22 77.4      | 2 82.5       | 119 85.2     |
| 1935... +0 3/4  | 5 82.2          | 7 84.1       | 24 87.0      | 1 78.0       | 21 80.5      | 12 76.7      | 2 83.5       | 60 84.2      |
| XV... +0 3/4    | 17 83.1         | 16 89.5      | 29 83.7      | 4 85.0       | 19 82.4      | 20 80.6      | 1 119.0      | 165 87.3     |
| 1934... +0 3/4  | 21 81.1         | 24 86.5      | 54 86.2      | 8 87.3       | 26 80.6      | 9 77.4       | 2 87.0       | 50 84.5      |
| XVI... +0 3/4   | 35 85.2         | 35 88.7      | 49 86.0      | 14 91.3      | 32 89.0      | 18 80.6      | 2 99.0       | 78 90.0      |
| 1933... +0 3/4  | 4 85.5          | 2 93.0       | 8 86.1       | 1 74.0       | 9 83.1       | 7 79.4       | —            | 17 92.4      |
| XVII... +0 3/4  | 4 84.8          | —            | 5 87.5       | —            | 6 83.2       | 4 83.5       | —            | 41 94.3      |
| 1932... +0 3/4  | —               | 4 87.5       | 2 98.5       | 1 82.0       | 5 88.0       | 2 76.0       | —            | 11 86.7      |
| XVIII... +0 3/4 | —               | 3 98.7       | 5 95.4       | —            | 1 102.0      | —            | —            | 17 93.9      |
| 1931... +0 3/4  | —               | —            | 2 106.0      | —            | 1 80.0       | 1 84.0       | —            | 1 88.0       |
| XIX... +0 3/4   | —               | —            | 2 117.0      | —            | 2 91.0       | —            | —            | 3 97.0       |
| 1930... +0 3/4  | —               | —            | 1 93.0       | —            | 1 77.0       | —            | —            | —            |
| XX... +0 3/4    | —               | —            | 1 99.0       | —            | —            | —            | —            | 5 112.4      |
| 1929... +0 3/4  | —               | —            | —            | —            | —            | —            | —            | —            |
| XXI... +0 3/4   | —               | —            | —            | —            | 1 95.0       | —            | —            | 4 110.5      |
| 1928... +0 3/4  | —               | —            | 1 100.0      | —            | —            | —            | —            | —            |
| XXII... +0 3/4  | —               | —            | 1 96.0       | 1 118.0      | —            | —            | —            | 1 82.0       |
| Total           | Number . . 200  | 149          | 1446         | 870          | 740          | 303          | 200          | 1571         |

<sup>1)</sup> N = Number, M = Mean.**Cod.****The Stock in 1950.****1. Young Cod of the Age-Groups I-III.**

Hauls with eel-hand seine were taken at different stations along the coast from Holsteinsborg (67°00'N.) to Godhavn (69°15'N.) in order to get samples of small cod of the three youngest age-groups. Among these age-groups only individuals belonging to the II and III-group were caught, the III-group being especially abundant. It was thus seen that the 1947 year-class was very rich, as

was also the case in the two previous years. (See Ann. Biol. 1949, p. 43).

**2. The Age Composition.**

In Table 15 are given the results of age-determinations of a total of 5,345 cod collected along the West Greenland coast and on Fyllas Bank. The majority were collected at the various Greenland fisheries stations. Samples were also taken by the research ships "Dana" and "Adolf Jensen". The samples have been combined according to regions. The figures



give the percentages of the different age-groups in the catches in each region. It is seen that the 1934 year-class, which was very important in the fisheries for several years, was abundant only in the samples from the northernmost districts (24.8 %) while it was of only slight importance in the middle and southern districts.

The 1942 year-class was of great importance in all the districts excepting Godthåb where the age composition of the cod stock differs very much from that in the other districts. The samples from Godthåb district were collected mainly in the Godthåb fjord where there is a special fjord population which is a little different from the population in coastal waters. The 1935 year-class predominated in the catches in Julianehåb; this was not expected as the results of the stock analyses in previous years showed this year-class to be of no special importance. The 1945 year-class was rich in the sample from Fyllas Bank and was also well represented in the sample from Julianehåb district.

### 3. Average Lengths of different Age-Groups.

In Table 16 are given the average lengths of the different age-groups of cod in seven different samples from West Greenland.

The average lengths of corresponding age-groups differ only to a slight degree between districts. As usual, the sample from Godthåb district shows lower values than do those from the other districts for the mean lengths of corresponding age-groups.

P. M. HANSEN.

### The Bank Cod.

The Norwegian Institute of Marine Research has carried out fishery investigations in the Davis Strait since 1948. Every year otoliths and length measurements of cod have been collected. The age composition of the cod in the different seasons from 1948 to 1951 is shown in Figure 35. The analysis treats as one unit all cod taken on all the offshore banks. It appears from the figure that in 1948 the cod born in 1934 and 1936 dominated the fishery. According to Dr. PAUL HANSEN the year-class 1934 was the richest ever observed in the fjords and inshore waters. The variations in the size of year-classes seem to correspond in

both inshore and offshore waters. The cod belonging to the 1934 year-class mostly became sexually mature at an age of 7 years, i.e. in 1941, and in the succeeding years this year-class predominated in the catches of the Greenlanders. As shown in the figure, the 1934-class was still rather strong on the offshore banks in 1948.

Our material shows that already in 1948 a new large year-class, viz., the brood born in 1942, was forthcoming in the bank fishery. In 1948 this year-class constituted 9 % of the catch. In 1949 cod belonging to this year-class were caught in increasing numbers and made up 19 % of the catch. In 1950 the percentage increased to 30, and in 1951 the 1942 year-class contributed about 31 % of the catch in the bank long-line fishery. This year-class must be considered very rich.

During the investigations in 1949 we succeeded in obtaining fairly large samples of cod from each of the several banks in the Davis Strait. The samples were from catches taken in the ordinary course of long-line fishing. The size of the fish varied between 45 and 135 cm., the mean size of the whole catch being 74.67 cm. However, the size composition of the catches showed marked differences from one bank to another. In Figure 36 the size

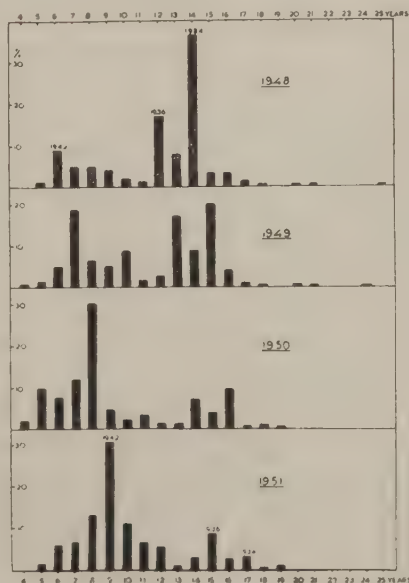


Figure 35. Age composition of cod on the offshore banks in the Davis Strait in the different seasons from 1948 to 1951.

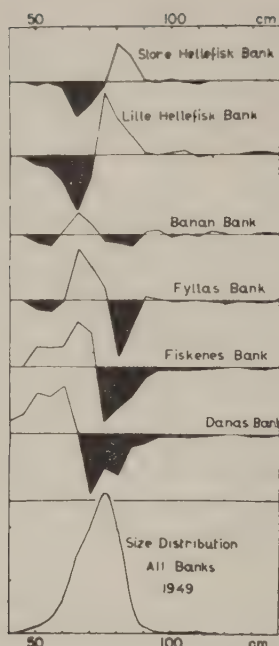


Figure 36. Size distribution of cod on the West Greenland Banks (bottom), and the distribution of each Bank shown as deviations from the mean in each 5-cm. group in 1949.

distributions of the fish are shown as deviations from the mean of the whole area. The figure clearly demonstrates that the cod population on the northern banks contained a relatively high proportion of large fish, while on the southern banks cod of smaller size predominated. This fact also corresponds with the opinion of the commercial fishermen fishing in these waters. The mean size of the cod on the various banks reckoned from north to south in 1949 were as follows:—

|                             |           |
|-----------------------------|-----------|
| Store Hellefiske Bank . . . | 75.06 cm. |
| Lille Hellefiske Bank . . . | 76.65     |
| Banan Bank . . . . .        | 73.66     |
| Fyllas Bank . . . . .       | 72.25     |
| Fiskenes Bank . . . . .     | 69.12     |
| Danas Bank . . . . .        | 67.15     |

However, this variation in the composition of the cod populations on the different banks was not only indicated by the size of the fish, but also by the age composition, as shown in Figure 37. On the southern banks the younger age-groups of cod constituted the major part of the catch, the year-classes 1942 and 1943 being particularly prominent. On

the northern banks we find on the other hand that older fish predominated in the catches, the large and old cod of the 1934 and 1936 groups being very conspicuous.

The results of the investigations in 1949 seem to indicate that a segregation within the cod population may exist in the Davis Strait with the result that the larger and older fish tend to gather on the northern banks while the younger age-groups seem to prefer the southern banks. As material covering all the banks has not been collected in other years, we are not able to state with any certainty whether this segregation within the cod population is a constant feature. However, our experience in later years indicates that such is the case. Both in 1950 and in 1951 the commercial fishermen preferred to fish on the northern banks where large-sized cod were more numerous than on the southern banks. Material collected on Store Hellefiske Bank in 1951 showed that in this northern area a considerable quantity of large and old fish were still to be found. They were mainly 15 and 17-year-old specimens belonging to the 1934 and 1936 year-classes. However, as shown in Fig. 35, these two year-classes which had

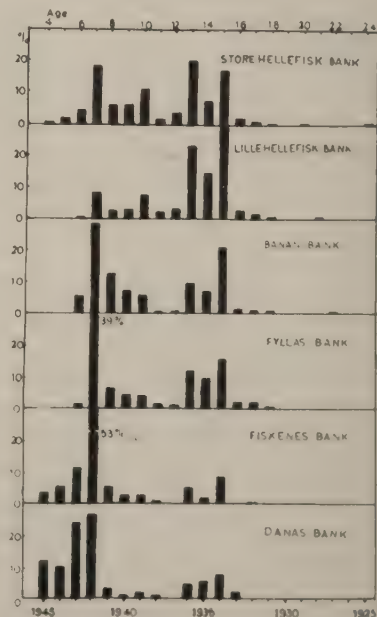


Figure 37. Age composition of cod on the West Greenland Banks in 1949 from north (top) to south (bottom).

been so rich in preceding years, were relatively much reduced by 1950—51, and they will in the future probably be of no particular significance to the long-line fishery on the banks.

In the coming years it is expected that the 1942 year-class of cod will constitute the major part of the long-line catch on the banks. There are, furthermore, several younger broods which promise to become rich and which will influence the fishery in due course of time. In 1950 large samples of young cod were obtained on the Banan Bank or southern tip of Lille Hellefiske Bank by means of a fine meshed pareja trawl. The age composition of one of these trawl samples is shown in Figure 38. Among the young cod were three promising classes, namely the broods from 1942, 1945 and 1947. As mentioned above the 1942-class has also been very numerous in the ordinary long-line catches during recent years. In the trawl sample the 1947 year-class appeared to be particularly rich. This group is as yet too small to enter into the long-line catches, and it will hardly appear in any numbers in the commercial fishery until 1954—55 and subsequent years. The 1945 year-class, although of less strength, must also be expected to become important in the future fishery, and it will probably begin to appear in long-line catches by 1952—53.

According to Dr. PAUL HANSEN the 1945 and 1947 year-classes have also been observed in great quantities in the Greenland fjords; he proclaims that the 1947 year-class is the richest ever created in Greenland waters and expects that in the future it will provide a cod fishery of great importance to the Greenlanders.

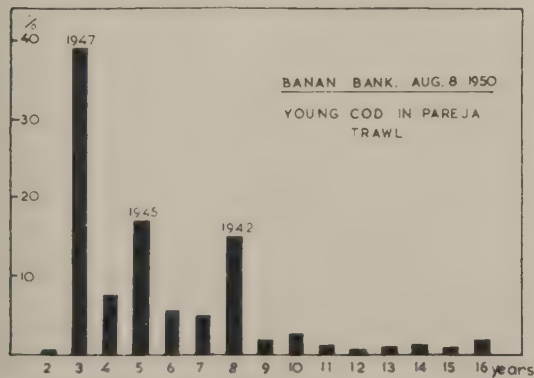


Figure 38. Age composition of small cod caught in a fine-meshed trawl on the Banan Bank in the summer 1950.

With our present knowledge of the cod population and its recruitment both in inshore and offshore waters it can safely be stated that the problem of overfishing in Greenland waters does not exist at present. Furthermore the problem of overfishing need not be considered at any rate within the next 5 years, presuming of course in the meantime the natural conditions do not change radically and that the fishery does not expand abnormally.

Our observations indicate that in the 1952 fishing season cod belonging to the 1942 year-class will make up the major part of the long-line catch. The average size of the fish of this year-class will be well above 73 cm. Also the 1943—45 year-classes will to some extent add to the salt fish production although they will still be of rather small size according to Norwegian standards. During last season (1951) the latter year-classes made up 26% of the catch, while the 1942 year-class alone made up 31 per cent. It is expected that the four year-classes 1942—45 will increase their total contribution next year to 60—70% of the catch, while the rest will be made up of older fish. On account of the influx of younger year-classes and the decreasing number of old fish, the average length of the line-caught fish will, in the next few years, probably be somewhat less than has been the case during the seasons 1948—51.

BIRGER RASMUSSEN.

### Marking Experiments.

A report on cod marking experiments in Greenland waters between 1924 and 1935 was published in 1935<sup>1)</sup>. Of the cod marked in that period 71 per cent. were liberated in the fjords and inshore waters, while 29 per cent. were liberated on the banks. One of the conclusions reached was that there occurred only a slight interchange between the bank cod and the fjord cod and vice versa. Another finding was that, particularly in the years 1929—33, a large number of cod immigrated to Iceland; most of these immigrants were marked in the southern districts of Greenland.

The Norwegian Institute of Marine Research carried out marking experiments in the summers of 1948—51 on the offshore banks in the

<sup>1)</sup> P. M. HANSEN, AD. S. JENSEN & Å. V. TÅNING: Cod marking experiments in the waters of Greenland 1914—1933. Medd. Komm. Danmarks Fisk.- og Havunders., Ser. Fisk. 10, 1, 1935.



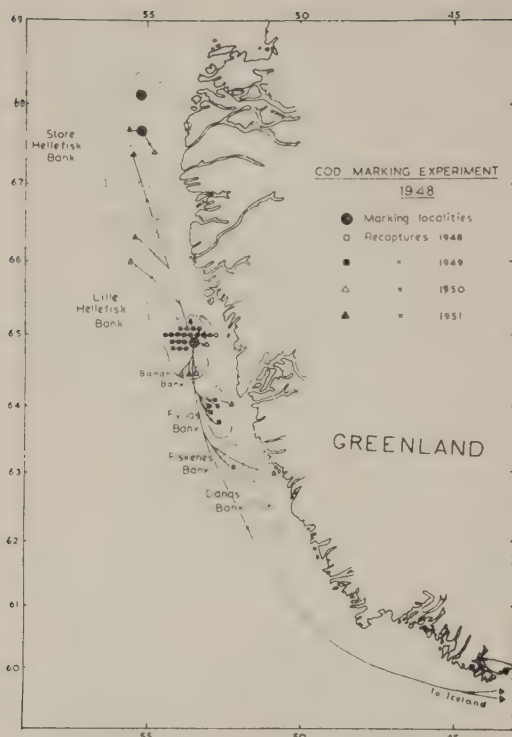


Figure 39. Cod marking experiments in 1948 and recaptures up to 1951.

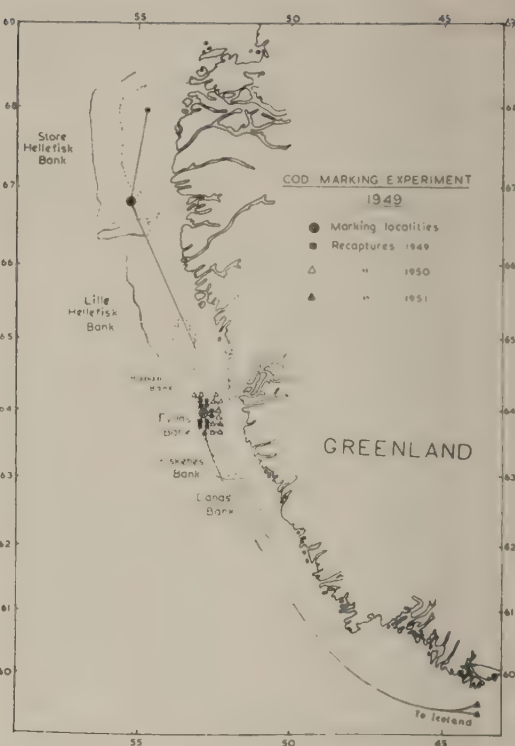


Figure 40. Cod marking experiments in 1949 and recaptures up to 1951.

Davis Strait. During the four seasons a total of 1025 cod were marked. So far the total number of recaptures recorded from these markings is 75, or 7.3 per cent., but still more recaptures are expected particularly from the markings in 1950 and 1951. A preliminary survey of the results hitherto obtained will be given in the present report.

#### Cod Marking 1948.

Between 31. July and 8. August 1948 a total of 387 cod were marked, 333 of them on Lille Hellefiske Bank and 55 in different places on Store Hellefiske Bank. (Figure 39). The type of tag used was a yellow plastic disc fastened in the gill cover with silver wire. From the 1948 markings a total of 39 tags, or 10 per cent. of the cod released, have been returned.

The cod marked on Lille Hellefiske Bank have given 37 recaptures, and those on Store Hellefiske only 2.

Of the cod marked on Lille Hellefiske Bank, 3 were recaptured within the same season. One of them was taken not far from the marking spot, one was recaptured on the Banan Bank about 30 miles further south, while one had migrated about 110 miles southwards in 80 days and was caught on the Fiskenes Bank.

In the 1949 season, one year after liberation, 23 recaptures were made, viz. 18 on the same bank where liberated, and 5 on the Fyllas Bank about 60 miles to the south.

In 1950, 2 years after liberation, 7 recaptures were recorded, viz. 2 on Store Hellefiske Bank, respectively 75 and 150 miles north of the marking spot, 1 in the same locality where marked, 1 on the Banan Bank 30 miles south of the marking spot, 1 at the entrance to the Fiskenes fjord 130 miles to the south and finally 2 individuals which had migrated the distance of 1200 miles to Iceland, where they were recaptured one on 16. January and the other on 25. April 1950.

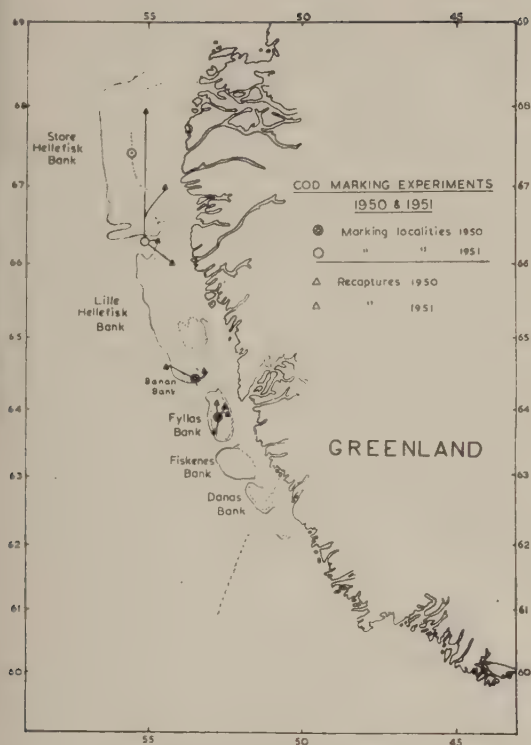


Figure 41. Cod marking experiments in 1950 and 1951 with subsequent recaptures.

In 1951—3 years after liberation—4 recaptures were recorded. One was caught in the same locality where liberated, one had migrated 100 miles northwards to the southern edge of Store Hellefiske Bank, one had migrated 30 miles southwards to the Banan Bank, and one had migrated 60 miles southwards to the eastern edge of the Fyllas Bank.

The two recaptures of cod from the 1948 marking on Store Hellefiske Bank were made in 1950, 2 years after liberation, not far from the spot where tagged.

Summarizing the results of the 1948 marking experiment we find that, of the total returns, 7.7% had migrated more than 30 miles northwards, 33.3% had migrated more than 30 miles southwards—two of the latter to Iceland—, while 59.0% were recaptured near the spot of tagging. Furthermore, only one of the recaptures in Greenland waters was made close to shore while the rest were recaptured on the banks.

#### Cod Marking 1949.

Between 31. July and 3. August 143 cod were marked, viz. 128 on Fyllas Bank and 15 on Store Hellefiske Bank. (Fig. 40). The type of tag used was a yellow plastic disc fastened in the gill cover with a loop of stainless steel wire. From the 1949 markings a total of 25 tags have been returned, or 17.5% of the cod released.

The cod marked on Fyllas Bank have so far given 23 recaptures. Within 2½ months after liberation 10 recaptures were made, all of them on the same bank where tagged. In the fishing season of 1950—1 year after liberation—12 recaptures were made, 11 of them near the tagging locality and 1 at Iceland on 16. June about 10½ months after liberation. In 1951 only one recapture was recorded, viz. a tag returned from the south coast of Iceland on 20. April, about 2 years and 9 months after liberation.

From the 15 cod marked on Store Hellefiske Bank 2 tags have been returned. One individual had migrated 70 miles northwards on the same bank and was recaptured after 35 days. The other had migrated 180 miles southwards to the Fyllas Bank where it was recaptured about 1 year after liberation.

Summarizing the results of the 1949 marking experiment we find that, of the total returns, 4.0% had migrated more than 30 miles northwards, 12.0% including the fish immigrated to Iceland had migrated southwards, while 84.0% had been recaptured in the same area where liberated. None of the cod had migrated from the banks to inshore waters.

#### Cod Marking 1950.

Between 6. and 12. August 1950 295 cod were marked, of which 185 were liberated on Fyllas Bank and 110 on the Banan Bank (Fig. 41). The type of tag used was a hydrostatic tube (LEA's tag) fastened to the gill cover by a loop of stainless steel wire. From the 1950 marking experiment 6 tags have been returned, or 2.0% of the cod released.

From the cod marked on Fyllas Bank 4 recaptures were recorded, all of them taken on the same bank and not far from the marking locality. Two individuals were recovered in the same season, the two others during the fishing season of 1951—about one year after liberation.

The tagging on the Banan Bank has given 2 returns, both of them on the same bank and

less than 30 miles from the marking locality. The tags were returned in 1951 about one year after liberation.

The 1950 marking experiment shows no migrations away from the bank where the cod were marked.

#### Cod Marking 1951.

In the latter half of July 1951 200 cod were marked. Of these, 100 were released on Store Hellefiske Bank and 100 in the Holsteinsborg Deep which separates the Store Hellefiske Bank from the Lille Hellefiske Bank (Figure 41).

The marking experiment in the Holsteinsborg Deep ought to prove of particular interest. Towards the end of July 1951 large shoals of cod were observed near the surface in this region. The cod were feeding on swarms of sandeels and capelan. The body colour of this shoaling cod was strikingly different from that of the ordinary bank cod. While the latter generally is marbled light brown, the pelagic Holsteinsborg cod had very dark, almost black spots and a pectoral fin with a blueish tint. Presumably this type of fish belonged inside the Holsteinsborg fjord or in neighbouring districts and had migrated out into open water in order to feed during the later part of the summer.

From the cod marked in the Holsteinsborg Deep 5 recaptures have so far been recorded, all of them within a month after tagging. Two individuals had migrated respectively 45 and 100 miles to the north where they were recaptured in the shallow area of Store Hellefiske Bank. A third individual had migrated a comparatively short distance to the east. A fourth had migrated about 30 miles to the

south-east and was recaptured on the northern part of Lille Hellefiske Bank. For the fifth individual data as to time and place of recovery are lacking.

Summarizing the results of the tagging experiments through all 4 seasons we find that 69% of the recaptures were made in the same area where the fish were marked and that these recoveries were made over a period of 4 years. This indicates that the various banks may possibly have more or less local cod populations which stay on the same banks for a succession of years. Only 8% of the marked fish showed a northwards tendency in their migrations, while 23% (including the immigrants to Iceland which constituted 5.4%) had migrated any appreciable distance southwards. The results of the experiments so far confirm the view that the bank cod intermix only to a very small degree with the populations of cod found in coastal waters and in the fjords of West Greenland.

BIRGER RASMUSSEN.

#### Records of Rare Fishes.

Three specimens of rare fishes were landed at Aberdeen market by vessels fishing in the N.-W. area:

1. *Aphanopus carbo* LOWE, 108' W.  $1/4$ ' N. from Westmann Isles, Iceland, September 1951.
2. *Brama raii* (BLOCH), 25' S. of Munken Rock, Faroe, August 1951.
3. *Centrolophus niger* (GMELIN), 4' SE. from Ingolfshofdi Huk, Iceland, August 1951.

B. B. RAE, E. WILSON.



# Comité Atlantique.

## INTRODUCTION

Les contributions au présent rapport ont été apportées par :

- JENS SMED ..... Danemark.
- J. B. TAIT et J. H. FRASER ... Ecosse.
- F. NAVARRO, EMMA BARDAN,  
R. FERNANDEZ, M. OLIVER et  
J. M. NAVAZ ..... Espagne.
- J. LE GALL et ses collabora-  
teurs, R. LETACONNOUX..... France.
- J. FURNESTIN et MARIE-LOUISE  
FAURE, RENÉ COUPÉ, RENÉ  
GAIL, CLAUDE MAURIN et MAR-  
TIAL ROSSIGNOL ..... Maroc.

### I. Les Conditions de Milieu.

**A. Hydrographie-Hydrologie.** Les trois études présentées montrent la réalité d'une élévation de la température des eaux dans l'Atlantique Nord-Est, mise en évidence dans une partie importante de ce domaine: la Mer Celtique, prolongé jusqu'au 10° Long. W. Gr., et dans un secteur très localisé: le Pertuis Breton, dans les parages de La Rochelle.

**B. Plancton.** Les variations saisonnières du plancton sur les côtes marocaines, régulièrement étudiées depuis plusieurs années, font l'objet d'une quatrième note de: M.-L. FAURE.— J. H. FRASER donne un bref aperçu des résultats des observations faites au large de l'Ecosse.

### II. Les Poissons.

**A. Clupéidés.** Les recherches sur la biologie des Clupéidés progressent régulièrement suivant le programme élaboré en 1948 à la Conférence de la Sardine de Biarritz.

**B. Thonidés.** Les investigations sur la biologie et le comportement des Thons (*Germo alalunga* L. et *Thunnus thynnus* L.) sont activement poursuivies en France. Les résultats obtenus montrent l'importance des classes annuelles constituant le stock.

JEAN LE GALL.

# LES CONDITIONS DE MILIEU

## Hydrologie.

### Monthly Anomalies of the Surface Temperature in the Celtic Sea during the Years 1903-39 and 1946-50.

Ever since the foundation of the International Council the hydrography of the area to the south of Ireland and off the western-entrance to the English Channel has been studied intensively by the neighbouring countries. This is clearly indicated in an inspection of the hydrographical card-index of the Council where the temperature and salinity data are recorded. For the surface water it is possible to follow the variation of these quantities from month to month during the whole period. To know this variation might be of interest to the fishery biologists. Moreover, the variations of the water temperature are of interest in connection with the climatic changes which have taken place during the last decades.

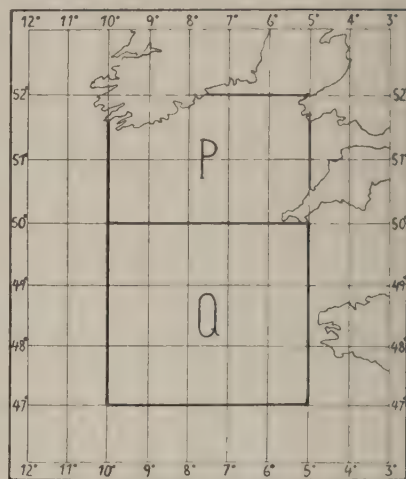


Figure 1. Location of the areas considered, P and Q.

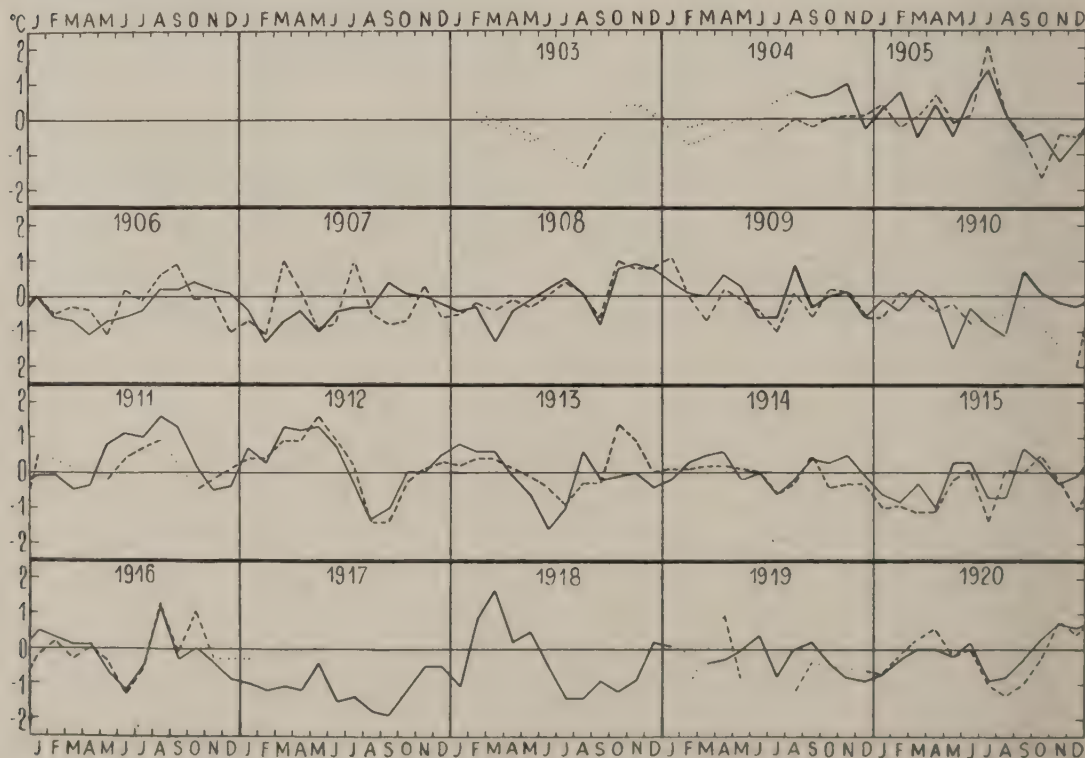


Figure 2 a. Monthly anomalies of the surface temperature in the areas P and Q (see Figure 1) during the years 1903 — 20. Solid lines: area P; dashed lines: area Q.

In the following, therefore, are given the variations of the surface temperature from month to month in two areas of the Celtic Sea.

This investigation is based on the observations contained in the hydrographical card-index of the Council. For the waters considered here the card-index contains observations from the periods 1903—39 and 1946—50. Figure 1 shows the areas within which the data were computed, viz., P:  $50^{\circ}$ — $52^{\circ}$ N.,  $5^{\circ}$ — $10^{\circ}$ W., and Q:  $47^{\circ}$ — $50^{\circ}$ N.,  $5^{\circ}$ — $10^{\circ}$ W.

From the material contained in the card-index, SANDSTRÖM (1943) has worked up and published grand monthly means of the surface temperature for the period 1900—1937 for each  $1^{\circ}$ -rectangle over most of the North Atlantic. Using SANDSTRÖM's means as standard values the temperature anomaly was computed for each  $1^{\circ}$ -rectangle in our areas and for each month. These anomalies were then averaged for the areas P and Q for each of the months in the whole period 1903—39. This procedure should make sure that the

results are not to any appreciable extent influenced by the local variation of the temperature. At this averaging the reliability of the means for each of the  $1^{\circ}$ -rectangles, indicated by the number of observations in the rectangle, was duly considered. Tables 1 and 2 give, for the areas P and Q respectively, the resulting monthly mean anomalies ( $\Delta$ ) as well as the number of observations (n) on which each of these mean anomalies are based. A graphical representation of the anomalies is given in Figure 2.

It appears from Figure 2 that the variations of the surface temperature in the area P conform very closely with those in area Q. Another interesting feature is a predominance of positive anomalies in these areas since about the middle of the twenties; obviously the increase in the surface temperature which is known to have occurred at many other localities (SMED 1949) is also apparent in these waters. In Table 3 we have, for each year, averaged the monthly anomalies given in

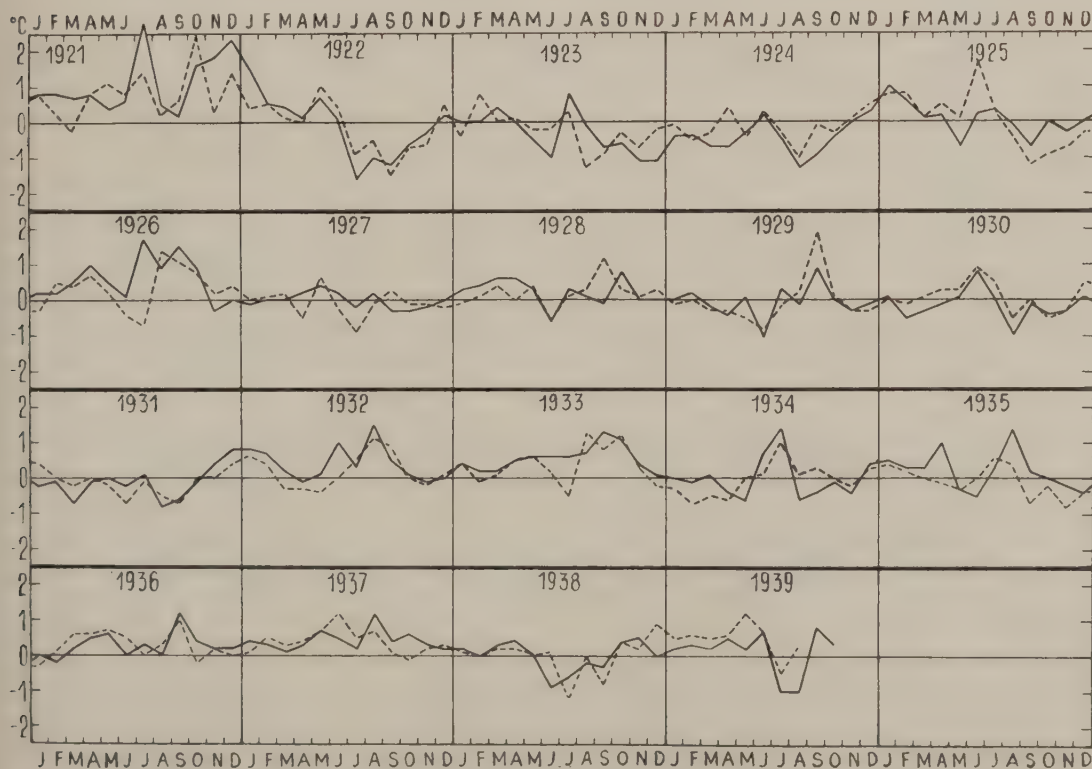


Figure 2 b. Monthly anomalies of the surface temperature in the areas P and Q (see Figure 1) during the years 1921—39. Solid lines: area P; dashed lines: area Q.



Table 1. Monthly Anomalies ( $\Delta$ ) and Numbers (n) of Observations of the Surface Temperature in the Area P (see Fig. 1) during the Years 1903-39.

|           | January  | February | March    | April    | May      | June     | July     | August   | September | October  | November | December |
|-----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|----------|----------|----------|
|           | $\Delta$ | $\Delta$ | $\Delta$ | $\Delta$ | $\Delta$ | $\Delta$ | $\Delta$ | $\Delta$ | $\Delta$  | $\Delta$ | $\Delta$ | $\Delta$ |
|           | n        | n        | n        | n        | n        | n        | n        | n        | n         | n        | n        | n        |
| 1903..... | 0.0      | 0.1      | -        | -        | -0.6     | 1        | -        | -        | -         | -        | 0.5      | 1        |
| 1904..... | -        | -0.7     | 1        | -0.3     | 1        | -        | -        | 0.8      | 5         | 0.6      | 4        | -        |
| 1905..... | 0.3      | 0.8      | 2        | 0.4      | 3        | 0.7      | 12       | 0.1      | 27        | -0.6     | 4        | -0.3     |
| 1906..... | 0.0      | 0.8      | -0.7     | 1.1      | 25       | -0.7     | 42       | 0.2      | 28        | -0.4     | 12       | -0.6     |
| 1907..... | 0.4      | 1.3      | -0.7     | 0.4      | 12       | -1.0     | 45       | -0.3     | 45        | 0.4      | 8        | 0.1      |
| 1908..... | 0.4      | 5        | 1.3      | 5        | -0.4     | 4        | -0.1     | 32       | 0.2       | 7        | 0.0      | -0.2     |
| 1909..... | 0.4      | 6        | 0.0      | 4        | 0.6      | 6        | 0.3      | 51       | -0.6      | 6        | 0.9      | 41       |
| 1910..... | -0.1     | 5        | -0.4     | 10       | 0.2      | 4        | -1.5     | 13       | -0.3      | 7        | 0.1      | 71       |
| 1911..... | -0.1     | 6        | -0.1     | 8        | -0.5     | 6        | 0.8      | 20       | -1.1      | 18       | -0.2     | 18       |
| 1912..... | 0.7      | 9        | 0.3      | 31       | 1.3      | 11       | 0.7      | 12       | 1.6       | 14       | -0.5     | 11       |
| 1913..... | 0.8      | 12       | 0.6      | 31       | -0.6     | 26       | -0.3     | 14       | -1.3      | 34       | 0.0      | 22       |
| 1914..... | 0.2      | 22       | 0.3      | 22       | -0.2     | 27       | -1.0     | 12       | 0.6       | 37       | 0.0      | 26       |
| 1915..... | -0.6     | 22       | -0.8     | 19       | 0.3      | 19       | -0.6     | 14       | -0.2      | 14       | 0.5      | 24       |
| 1916..... | 0.5      | 16       | 0.3      | 15       | 0.1      | 14       | -0.7     | 25       | 0.7       | 18       | -0.3     | 15       |
| 1917..... | -1.0     | 9        | -1.2     | 8        | -0.7     | 19       | -1.2     | 20       | -0.3      | 13       | 0.0      | 9        |
| 1918..... | -1.1     | 8        | 0.9      | 9        | -1.1     | 8        | -1.5     | 9        | -1.8      | 8        | -0.4     | 7        |
| 1919..... | 0.1      | 7        | -0.4     | 8        | 0.0      | 8        | -0.5     | 8        | -1.4      | 8        | -0.5     | 8        |
| 1920..... | -0.7     | 12       | 0.0      | 9        | -0.2     | 8        | 0.4      | 8        | 0.0       | 7        | -0.8     | 8        |
| 1921..... | 0.8      | 19       | 0.8      | 14       | 0.2      | 19       | 0.9      | 27       | -0.8      | 10       | 0.7      | 12       |
| 1922..... | 1.5      | 10       | 0.5      | 8        | 0.4      | 18       | 2.8      | 20       | 0.5       | 28       | 0.3      | 10       |
| 1923..... | 0.0      | 10       | 0.0      | 7        | 0.7      | 12       | 1.6      | 16       | -1.0      | 12       | 1.8      | 33       |
| 1924..... | 0.4      | 8        | -0.7     | 15       | -0.5     | 9        | 0.8      | 8        | -0.1      | 8        | -0.6     | 8        |
| 1925..... | 1.0      | 10       | 0.6      | 11       | -0.3     | 8        | 0.5      | 19       | -1.3      | 11       | -1.1     | 9        |
| 1926..... | 0.2      | 10       | 0.2      | 18       | -0.7     | 22       | 0.3      | 19       | -0.9      | 9        | 0.0      | 25       |
| 1927..... | 0.1      | 11       | 0.0      | 19       | 0.5      | 8        | 1.7      | 14       | -0.1      | 29       | -0.3     | 20       |
| 1928..... | 0.3      | 9        | 0.4      | 8        | 0.4      | 22       | 0.2      | 9        | 1.5       | 13       | 0.3      | 10       |
| 1929..... | 0.0      | 20       | 0.2      | 24       | 0.3      | 29       | -0.6     | 15       | -0.3      | 10       | -0.2     | 22       |
| 1930..... | 0.1      | 21       | -0.5     | 37       | 0.1      | 24       | 0.3      | 35       | 0.2       | 10       | 0.0      | 26       |
| 1931..... | -0.2     | 36       | -0.1     | 28       | 0.1      | 34       | -1.0     | 41       | -0.1      | 30       | -0.3     | 31       |
| 1932..... | 0.8      | 18       | 0.7      | 20       | 0.2      | 34       | 0.1      | 32       | -0.6      | 33       | 0.4      | 19       |
| 1933..... | 0.4      | 19       | 0.2      | 19       | 0.1      | 28       | 0.3      | 25       | 0.5       | 18       | -0.1     | 23       |
| 1934..... | 0.0      | 14       | -0.1     | 15       | 0.6      | 31       | 0.6      | 18       | 1.3       | 20       | 0.1      | 27       |
| 1935..... | 0.5      | 22       | 0.3      | 13       | 0.3      | 14       | 1.4      | 20       | 0.3       | 20       | -0.4     | 15       |
| 1936..... | 0.0      | 17       | -0.2     | 15       | 0.3      | 16       | -0.5     | 18       | -0.4      | 23       | -0.4     | 15       |
| 1937..... | 0.4      | 23       | 0.3      | 20       | 0.6      | 23       | 0.0      | 26       | 0.2       | 23       | -0.2     | 21       |
| 1938..... | 0.2      | 13       | 0.0      | 11       | 0.3      | 12       | 0.9      | 18       | 1.2       | 15       | 0.2      | 24       |
| 1939..... | 0.2      | 12       | 0.3      | 11       | 0.2      | 12       | 0.7      | 12       | -0.3      | 12       | 0.5      | 12       |
|           |          |          |          |          |          |          | 1.0      | 10       | 0.8       | 8        | 0.3      | 6        |

**Table 2. Monthly Anomalies ( $\Delta^{\circ}\text{C}$ ) and Numbers (n) of Observations of the Surface Temperature in the Area Q (see Fig. 1) during the Years 1903-39.**

|           | January | February | March   | April   | May     | June    | July    | August  | September | October | November | December |
|-----------|---------|----------|---------|---------|---------|---------|---------|---------|-----------|---------|----------|----------|
|           | △       | △        | △       | △       | △       | △       | △       | △       | △         | △       | △        | △        |
| 1903..... | —       | 0.2 4    | —       | —       | —0.4 4  | —       | —       | —1.4 1  | —0.5 8    | —       | 0.4 4    | —        |
| 1904..... | —       | —0.2 4   | —       | —0.0 4  | —       | —       | —0.4 3  | 0.0 4   | —0.2 10   | 0.0 10  | 0.1 12   | 0.1 9    |
| 1905..... | 0.4 10  | —0.2 13  | 0.1 12  | 0.7 6   | —0.1 17 | 0.1 22  | 2.1 8   | 0.1 26  | —0.5 28   | —1.7 9  | —0.4 42  | —0.5 23  |
| 1906..... | 0.0 12  | —0.5 35  | —0.3 11 | —0.4 17 | —1.1 58 | 0.2 7   | —0.1 10 | 0.6 48  | 0.9 19    | —0.1 12 | 0.0 34   | —1.0 18  |
| 1907..... | —0.7 8  | —1.1 40  | 1.0 16  | 0.2 21  | —0.9 37 | 0.8 6   | 1.0 12  | —0.5 28 | —0.8 9    | —0.1 23 | 0.3 42   | —0.6 11  |
| 1908..... | 0.5 20  | —0.2 48  | —0.4 13 | 0.1 15  | —0.3 71 | 0.0 23  | 0.4 20  | 0.1 49  | —0.6 12   | 1.0 20  | 0.8 44   | —0.6 6   |
| 1909..... | 1.1 24  | 0.0 57   | —0.7 14 | 0.2 16  | —0.1 73 | —0.4 22 | —1.0 51 | 0.1 44  | —0.6 19   | 0.2 17  | 0.1 62   | —0.6 6   |
| 1910..... | 0.6 9   | 0.1 5    | 0.0 1   | —0.4 3  | —0.2 13 | —0.8 8  | 0.7 2   | —0.9 7  | —0.3 4    | —       | —2.0 2   | —0.1 7   |
| 1911..... | 0.5 1   | —        | —       | —       | —0.2 19 | 0.4 2   | 0.7 2   | —       | —1.4 15   | —0.3 21 | —0.2 14  | 0.3 19   |
| 1912..... | 0.4 7   | 0.4 19   | 0.9 14  | 0.9 16  | 1.6 24  | 0.9 15  | 0.2 15  | —1.4 28 | —1.4 15   | —       | 0.1 7    | 0.3 10   |
| 1913..... | 0.2 20  | 0.4 23   | 0.4 24  | 0.1 25  | —0.1 25 | —0.4 19 | —0.9 19 | —0.3 31 | —0.3 7    | 1.4 24  | 0.9 23   | 0.0 16   |
| 1914..... | 0.1 39  | 0.1 25   | 0.2 32  | 0.2 21  | 0.1 41  | 0.0 40  | —0.6 25 | —0.3 22 | 0.5 20    | —0.4 28 | —0.3 29  | —0.3 16  |
| 1915..... | —1.0 22 | —0.9 21  | —1.1 19 | —1.1 11 | —0.2 21 | 0.1 25  | —1.4 24 | 0.1 27  | 0.0 23    | 0.5 15  | —0.2 21  | —1.1 14  |
| 1916..... | —0.2 22 | 0.2 13   | —0.3 13 | 0.0 6   | —0.4 33 | —1.3 33 | —0.6 34 | 1.3 28  | —0.1 13   | 1.1 7   | 0.3 2    | —        |
| 1917..... | —0.3 5  | —        | —       | —       | —       | —       | —       | —       | —         | —       | —        | —        |
| 1918..... | —       | —        | —       | —       | —       | —       | —       | —       | —         | —       | —        | —        |
| 1919..... | —1.0 1  | —0.2 9   | 0.3 13  | 0.6 1   | —0.8 2  | 0.0 26  | —1.0 42 | —1.3 39 | —1.0 44   | —0.3 26 | 0.8 17   | —0.6 9   |
| 1920..... | —0.7 17 | —0.2 9   | —0.2 5  | 0.8 21  | 1.1 8   | 0.8 21  | 1.4 54  | 0.2 36  | 0.6 28    | 2.5 30  | 0.3 38   | 0.4 8    |
| 1921..... | 0.4 16  | 0.5 27   | 0.1 22  | 0.0 31  | 1.0 49  | 0.4 79  | —0.9 28 | —0.5 48 | —1.5 35   | —0.7 25 | —0.6 25  | 0.5 17   |
| 1922..... | —0.4 2  | 0.8 1    | 0.0 1   | 0.1 3   | —0.2 10 | —0.2 15 | 0.3 9   | —1.3 5  | —0.9 2    | —0.3 4  | —0.7 6   | —0.2 15  |
| 1923..... | —0.1 1  | —0.5 6   | —0.3 7  | 0.4 2   | —0.4 11 | 0.3 18  | —0.3 9  | —1.0 49 | —0.1 13   | 0.3 19  | 0.1 26   | 0.5 14   |
| 1924..... | 0.8 18  | 0.8 21   | 0.1 27  | 0.5 18  | 0.1 41  | 1.7 16  | —0.2 24 | —0.4 36 | 1.2 17    | 0.9 16  | —0.7 24  | —0.3 18  |
| 1925..... | —0.3 17 | 0.5 22   | 0.4 32  | 0.7 26  | 0.2 23  | —0.4 20 | —0.7 24 | 1.4 50  | 1.1 27    | —0.8 17 | 0.2 41   | 0.4 24   |
| 1926..... | 0.0 13  | 0.1 29   | 0.2 17  | —0.5 21 | 0.7 29  | —0.2 17 | —0.9 18 | —0.1 32 | 0.3 4     | —0.1 17 | 0.1 12   | —0.2 15  |
| 1927..... | —0.1 10 | 0.1 1    | 0.4 12  | 0.0 17  | 0.4 41  | —0.6 21 | 0.1 31  | 0.3 26  | 1.2 36    | 0.3 18  | 0.1 32   | 0.3 35   |
| 1928..... | —0.1 31 | 0.2 28   | —0.1 30 | 0.3 32  | —0.5 27 | —0.8 38 | —0.1 36 | 0.2 41  | 1.9 59    | 0.1 32  | —0.3 36  | —0.3 25  |
| 1929..... | —0.1 37 | —0.1 28  | 0.1 34  | 0.3 26  | 0.3 40  | 0.9 16  | 0.5 33  | —0.5 36 | 0.0 30    | —0.5 32 | —0.3 33  | 0.5 18   |
| 1930..... | 0.4 36  | 0.0 20   | —0.2 28 | 0.0 28  | —0.2 34 | —0.9 20 | —0.1 22 | —0.5 31 | —0.7 29   | 0.0 28  | 0.0 29   | 0.4 19   |
| 1931..... | 0.6 29  | 0.4 27   | —0.3 22 | 0.3 27  | —0.4 19 | 0.0 34  | 0.5 32  | 1.1 25  | 0.9 35    | 0.0 22  | —0.2 28  | 0.1 31   |
| 1932..... | 0.4 18  | —0.1 29  | 0.1 30  | 0.5 30  | 0.6 29  | 0.2 34  | —0.5 19 | 1.3 33  | 0.8 28    | 1.2 18  | 0.3 25   | —0.2 34  |
| 1933..... | —0.3 27 | —0.7 1   | —0.5 18 | —0.6 30 | 0.0 31  | 0.1 22  | 1.0 30  | 0.1 36  | 0.3 20    | 0.0 34  | —0.2 29  | —0.4 31  |
| 1934..... | 0.4 26  | 0.2 18   | 0.0 39  | —0.1 25 | —0.3 36 | 0.0 21  | 0.6 37  | 0.4 34  | —0.7 30   | —0.2 22 | —0.8 12  | —0.4 31  |
| 1935..... | —0.3 31 | 0.1 22   | 0.6 11  | 0.6 27  | 0.7 32  | 0.5 22  | 0.0 14  | 0.3 5   | 1.0 5     | —0.2 9  | 0.2 8    | 0.0 20   |
| 1936..... | —0.3 31 | 0.5 13   | 0.3 23  | 0.4 20  | 0.7 21  | 1.2 20  | 0.5 24  | 0.7 22  | 0.1 19    | —0.1 22 | 0.2 16   | 0.3 17   |
| 1937..... | 0.1 29  | 0.0 19   | 0.2 19  | 0.2 47  | 0.0 55  | 0.1 20  | —1.2 49 | 0.0 24  | —0.8 16   | 0.4 30  | 0.2 17   | 0.9 16   |
| 1938..... | 0.1 17  | 0.0 19   | 0.2 19  | 0.2 47  | 0.0 55  | 0.1 20  | —1.2 49 | 0.0 24  | —0.8 16   | 0.4 30  | 0.2 17   | 0.9 16   |
| 1939..... | 0.5 16  | 0.6 21   | 0.5 16  | 0.6 56  | 1.2 24  | 0.7 19  | —0.5 18 | 0.3 11  | —         | —       | —        | —        |

**Table 3. Yearly Anomalies ( $^{\circ}\text{C}$ ) of the Surface Temperature in the Areas P and Q (see Fig. 1) during the Years 1903-39.**

|      | P                  | Q                  |      | P                 | Q    |
|------|--------------------|--------------------|------|-------------------|------|
| 1903 | 0.0 <sub>3</sub>   | -0.3 <sub>4</sub>  | 1922 | -0.1              | -0.1 |
| 1904 | 0.3 <sub>7</sub>   | -0.1 <sub>8</sub>  | 1923 | -0.3              | -0.2 |
| 1905 | 0.0                | 0.0                | 1924 | -0.4              | -0.1 |
| 1906 | -0.2               | -0.2               | 1925 | 0.0               | 0.1  |
| 1907 | -0.4               | -0.3               | 1926 | 0.6               | 0.4  |
| 1908 | 0.0                | 0.1                | 1927 | 0.0               | -0.1 |
| 1909 | 0.0                | -0.1               | 1928 | 0.2               | 0.2  |
| 1910 | -0.3               | -0.5 <sub>8</sub>  | 1929 | 0.0               | 0.0  |
| 1911 | 0.3                | 0.2 <sub>8</sub>   | 1930 | -0.1              | 0.1  |
| 1912 | 0.3                | 0.2                | 1931 | -0.1              | -0.1 |
| 1913 | -0.1               | 0.1                | 1932 | 0.4               | 0.2  |
| 1914 | 0.1                | -0.1               | 1933 | 0.6               | 0.4  |
| 1915 | -0.2               | -0.5               | 1934 | 0.0               | 0.0  |
| 1916 | -0.2               | -0.1 <sub>11</sub> | 1935 | 0.2               | -0.1 |
| 1917 | -1.1               | -0.3 <sub>1</sub>  | 1936 | 0.3               | 0.3  |
| 1918 | -0.1               | —                  | 1937 | 0.4               | 0.4  |
| 1919 | -0.3 <sub>11</sub> | -0.5 <sub>8</sub>  | 1938 | 0.0               | 0.0  |
| 1920 | -0.1               | -0.2               | 1939 | 0.1 <sub>10</sub> | 0.5  |
| 1921 | 1.1                | 0.8                |      |                   |      |

Tables 1 and 2, thereby making more conspicuous the predominance of positive anomalies in the later part of the period investigated. When the number of monthly anomalies on which the values in Table 3 are based is less than 12 the number is given as an index to the value.

Unfortunately no observations from the war years are available. For the years 1946-50, however, observations are again available. From these observations the anomalies recorded in Table 4 have been computed. It appears that there is still a close similarity between the anomalies for the two areas. The predominance of positive anomalies found for a period of years before the war is even more marked in post-war years, as is clearly shown in Table 5.

**Table 5. Yearly Anomalies ( $^{\circ}\text{C}$ ) of the Surface Temperature in the Areas P and Q (see Fig. 1) during the Years 1946-50.**

|      | P                 | Q                 |      | P   | Q   |
|------|-------------------|-------------------|------|-----|-----|
| 1946 | -0.1 <sub>1</sub> | -0.2 <sub>2</sub> | 1949 | 1.6 | 2.1 |
| 1947 | 0.8 <sub>11</sub> | 0.9 <sub>10</sub> | 1950 | 0.6 | 0.9 |
| 1948 | 0.4               | 0.5               |      |     |     |

In conclusion I should like to thank Mr. P. ALNØE who has made the calculations.

JENS SMED.

#### Literature.

SANDSTRÖM, 1943. Rapp. et Proc.-Verb., Vol. CXII, p. 62.  
SMED, 1949. Rapp. et Proc.-Verb., Vol. CXXV, p. 21.

#### Travaux de l'Ecosse.

In extension southwards of this country's normal field of hydrographic operations in the Faroe-Shetland Channel region, a survey of North-Eastern Atlantic waters west of the British Isles to longitude  $17^{\circ}\text{W}$ . was carried out in the month of June, 1951. To longitude  $15^{\circ}\text{W}$ ., the position occupied for serial temperature-salinity observations, and, at the majority, for oxygen and free phosphate determinations and the liberation of surface drift-bottles, are shown in the accompanying figure, together with the surface isotherms.

The region surveyed embraced the greater parts of the routes from the Firth of Clyde and the English Channel to and from the Ocean Weather Stations I (Lat.  $59^{\circ}\text{N}$ ., Long.  $19^{\circ}\text{W}$ .) and J (Lat.  $52^{\circ}30'\text{N}$ , Long.  $20^{\circ}\text{W}$ .). The liberation of surface drift-bottles on these routes in 1950 produced some unexpected

**Table 4. Monthly Anomalies ( $^{\circ}\text{C}$ ) and Numbers (n) of Observations of the Surface Temperature in the Areas P and Q (see Fig. 1) during the Years 1946-50.**

| Area | Jan.       | Febr.      | March      | April      | May        | June       | July       | August     | Sept.      | Oct.       | Nov.       | Dec.       |
|------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| P    | $\Delta$ n | $\Delta$ n | $\Delta$ n | $\Delta$ n | $\Delta$ n | $\Delta$ n | $\Delta$ n | $\Delta$ n | $\Delta$ n | $\Delta$ n | $\Delta$ n | $\Delta$ n |
| 1946 | —          | —          | —          | —          | —          | —          | 0.1 8      | —          | —          | —          | —          | —          |
| 1947 | 0.7 3      | —          | -0.1 5     | 0.4 7      | -0.1 8     | -0.5 10    | -0.6 10    | 1.7 10     | 3.1 5      | 1.3 11     | 1.5 10     | 1.0 10     |
| 1948 | 0.8 9      | 0.3 9      | 0.8 10     | 0.7 7      | 1.1 11     | -0.2 10    | -1.3 9     | 0.0 8      | -0.1 8     | 0.6 8      | 0.8 8      | 1.2 9      |
| 1949 | 1.2 11     | 1.3 11     | 1.1 12     | 1.2 12     | 1.0 14     | 1.4 11     | 2.6 17     | 2.0 16     | 2.8 13     | 2.4 18     | 1.3 16     | 1.2 15     |
| 1950 | 1.3 17     | 1.2 16     | 1.5 17     | 0.7 35     | 0.7 27     | 1.4 38     | 0.7 21     | 0.5 15     | -0.2 18    | 0.0 18     | 0.3 14     | -0.4 14    |
| Q    |            |            |            |            |            |            |            |            |            |            |            |            |
| 1946 | —          | —          | —          | —          | —          | —          | -1.0 17    | —          | —          | —          | —          | 0.7 6      |
| 1947 | 0.4 33     | —          | 0.2 11     | 0.3 14     | —          | 0.2 17     | 0.7 24     | 2.4 16     | 2.0 9      | 1.3 24     | 0.7 16     | 0.5 16     |
| 1948 | 0.3 8      | 0.5 16     | 0.8 16     | 0.8 25     | 1.7 25     | -0.4 8     | -0.6 11    | -0.4 4     | -0.6 14    | 0.6 7      | 0.4 13     | 2.1 12     |
| 1949 | 2.6 26     | 2.5 38     | 1.7 29     | 1.5 35     | 1.1 61     | 1.5 29     | 3.0 77     | 2.4 72     | 3.5 58     | 2.4 84     | 1.4 69     | 1.4 62     |
| 1950 | 1.6 79     | 1.7 64     | 1.8 64     | 1.3 64     | 0.8 79     | 1.6 87     | 1.2 68     | 0.7 57     | 0.2 37     | 0.2 43     | 0.1 48     | -0.2 48    |



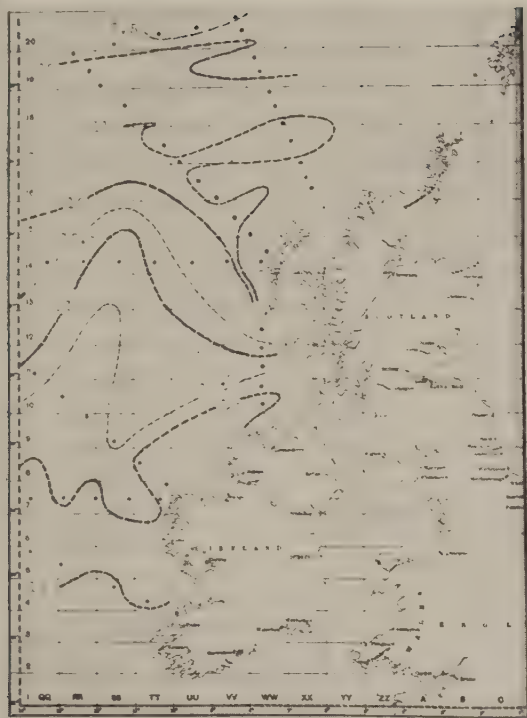


Figure 3. Surface temperatures (°C.).

results, chiefly of recoveries on west Irish, English and even French coasts, of bottles which had been put into the sea far west and north of their stranding places. This feature appears to link up with Dr. L. H. N. COOPER's investigations in approximately the same region<sup>1)</sup>, and 1951 results, including the recovery of drift-bottles from the Rockall Bank region on the west and north-west coast of Ireland, are similarly indicative of complex eddy-circulation in the region west of Ireland. A detailed report on investigations in this region will appear elsewhere in due course.

J. B. TAIT.

### Observations hydrologiques périodiques dans le Pertuis Breton.

Au cours de l'année 1951 des observations hydrologiques périodiques, partielles ou com-

<sup>1)</sup> L. H. N. COOPER: »The Physical and Chemical Oceanography of the Waters bathing the Continental Slope of the Celtic Sea«, Journ. Mar. Biol. Assoc., XXX, No. 3, Feb. 1952.

plètes, ont été effectuées, dans 20 stations fixes situées dans le Pertuis Breton, entre l'île de Ré et la zone qui s'étend au nord de la Rochelle, à la limite de la Charente Maritime et de la Vendée.

Les températures et salinités moyennes suivantes on été observées en surface:

| Date  | t°    | S ‰   | Nombre de stations |
|-------|-------|-------|--------------------|
| 5/2   | 7°75  | 30.28 | 13 et 9            |
| 28/2  | 8°47  | 29.67 | 11 et 10           |
| 19/4  | 12°70 | 29.96 | 12 et 12           |
| 4/6   | 16°63 | 32.52 | 15 et 15           |
| 12/7  | 19°27 | 33.42 | 15 et 15           |
| 14/8  | 18°97 | 34.30 | 18 et 18           |
| 4/10  | 17°91 | 33.50 | 18 et 18           |
| 6/11  | 13°15 | 33.50 | 20 et 20           |
| 14/12 | 9°30  | 31.98 | 19 et 19           |

L'examen des cartes périodiques donnant la température et la salinité en surface montre que l'hydrologie de la région du Pertuis Breton est la résultante de deux systèmes opposés: eaux côtières et eaux du large, dont l'importance relative varie au cours de l'année.

*En fin d'hiver*, des eaux peu salées d'origine côtière provenant de la Baie de l'Aiguillon, dominent dans toute la partie nord du Pertuis mais se heurtent en profondeur à une nappe plus salée ayant son origine dans les eaux du large et qui subsiste dans une fosse située le long de la pointe NNE. de l'île de Ré. L'existence de cette nappe profonde se manifeste en surface par une véritable résurgence le long de la partie centrale de la côte de l'île.

*Au printemps* la poussée des eaux profondes venant du large se traduit par une augmentation de la salinité de la résurgence et l'apparition d'eaux plus salées en surface à l'entrée du Pertuis.



Figure 4. Position des stations.



Figure 5 a. Salinités et températures en surface.

Au cours de l'été on assiste au recul des eaux côtières dans toute la région, y compris dans la Baie de l'Aiguillon, et leur remplacement par des eaux dont la salinité atteint 34.5 ‰.

En automne, enfin, le phénomène inverse se déclenche et la salinité diminue dans tout le Pertuis; mais, une masse d'eaux à salinité relativement élevée subsiste le long de la côte de l'île de Ré.

Les observations effectuées montrent donc que les deux rives du Pertuis Breton ont une hydrologie sensiblement différente: la côte NE. de l'île de Ré conserve toute l'année le caractère d'une côte baignée par des eaux à salinité élevée ou relativement élevée; la côte vendéenne et charentaise, au contraire, a un régime franchement côtier avec des variations importantes de la salinité selon les saisons.



Figure 5 b. Salinités et températures en surface.



Figure 5 c. Salinités et températures en surface.

Ce contraste entre les deux rives du Pertuis est particulièrement net en fin d'hiver lorsque la Baie de l'Aiguillon est alimentée par d'importants apports d'eaux douces.

Le coureau de la Pallice ne joue qu'un rôle très secondaire dans l'hydrologie du Pertuis Breton.

R. LETACONNOUX.

## Plancton.

### Plankton Investigations by the Scottish Research Ship "Scotia".

During June and early July 1951, the "Scotia" made a hydrographic-plankton investigation of the oceanic area to the west of Scotland and Ireland.

It would appear from the results that a water mass containing large numbers of plankton organisms originating from the Biscayan or Lusitanian area approached the deep water channel between Scotland and Rockall by way of Porcupine Bank. This plankton included such species as *Sagitta lyra*; the pelagic annelids *Vanadis* and *Travisopsis*; the Thaliacea *Thalia democratica* and *Doliolletta gegenbauri*; the Medusae *Periphylla*, *Nausithoe* and *Rhopalonema*, and 18 species of siphonophores. Of these, only a few species penetrated further north, as a barrier appeared to be formed by the southerly extension of cold deep water

bringing with it *Calanus hyperboreus*, *Metridia longa*, *Sagitta maxima* and *Eukrohnia hamata*. The remaining Biscayan plankton became mixed with species from the north-east Atlantic including *Salpa fusiformis*, *Agalma elegans*, *Clione limacina* and *Aglantha digitata* as well as with some of the boreal species as though this community was persisting in a swirl.

As the results of these investigations are correlated with the conditions in the N.W. Area the details are more fully reported to that committee, and a chart is included there showing the positions of the plankton stations.

J. H. FRASER.

### Note planctonique (Juin-Juillet 1951)<sup>1)</sup>.

*Calanus finmarchicus* GUN., venant de l'Atlantique apparaît à l'entrée de la Manche dans les eaux à 16°C. en surface. Sa présence est

<sup>1)</sup> Voir carte des stations, p. 68, Fig. 1.





Figure 6.

dominante dans le plancton prélevé dans les eaux de surface à salinité de 35.25 ‰ (voir isohaline). Dans cette même zone, les espèces atlantiques *Anomalocera Patersoni*, *Templ.* et *Sagitta elegans* VER., voisinent avec l'espèce tempérée *Candacia armata* BOECK (très rare à la Station 539), *Noctiluca miliaris* SUR., et des Euphausiacées venues de l'ouest.

Dans les eaux continentales, *Acartia clausi*, GIESBR. domine; *Sagitta setosa* MUL. y est assez abondante.

Les Copépodes néritiques sont nombreux (*Centropages typicus* KRÖYER, *Temora longicornis* MUL. *Isias clavipes* BOECK). Leur nombre diminue en approchant des eaux atlantiques où apparaît plus fréquemment *Centropages hamatus* LILLJ.

Des Appendiculaires et des Cladocères (*Evadne spinifera*, MUL.) sont épars à l'entrée ouest de la Manche.

J. FLEURY.

## Le Zooplancton de la Zone Côtière du Maroc.

Année 1950-4° note.

Nous avons poursuivi en 1950 l'étude, commencée en 1947, du zooplancton de la zone côtière marocaine<sup>1)</sup>.

Nos prélèvements, correspondant à des pêches de surface d'une durée de 5 minutes et à une vitesse de 5 noeuds, ont été effectués au filet à plancton de 30 cm. de diamètre.

<sup>1)</sup> Voir 1° note (année 1947), 2° note (année 1948), 3° note (année 1949), respectivement présentées au congrès du C.I.P.E.M. à Copenhague en 1948 et 1950 — à Edimbourg en 1949. (Voir Ann. Biol. V, p. 38; VI, p. 49 et VII, p. 47).

Ces prélèvements, répartis comme d'ordinaire en 4 séries trimestrielles suivant 16 lignes perpendiculaires au rivage, du Cap Spartel au Cap Juby, à raison de 3 à 6 récoltes par ligne, ont été faits aux dates suivantes:

|               |                         |
|---------------|-------------------------|
| Série d'hiver | du 15- 2-50 au 9- 3-50  |
| de printemps  | du 16- 5-50 au 23- 5-50 |
| d'été         | du 31- 7-50 au 12- 8-50 |
| d'automne     | du 17-11-50 au 29-11-50 |

Désirant comparer nos résultats avec ceux déjà obtenus, nous avons conservé les procédés d'étude qu'indiquaient nos précédentes notes: détermination et numération des formes planctoniques, analyses quantitatives en volume, établissement de cartes de répartition en fonction de la température de l'eau, du lieu et de la saison des prélèvements.

## Analyses quantitatives (en cm.<sup>3</sup>).

| Lignes                                        | Hiver                    | Printemps | Été | Automne |
|-----------------------------------------------|--------------------------|-----------|-----|---------|
| <b>Secteur Nord</b>                           |                          |           |     |         |
| Tanger.....                                   | 10                       | 5         | 1   | 5       |
| Spartel.....                                  | 13                       | 181       | 3   | 6.5     |
| Arcila.....                                   | 5                        | 20        | 7   | 6       |
| M. B. Selham.....                             | 12                       | 22        | 4   | 4       |
| O. Sebou.....                                 | 31                       | 15        | 6   | 13      |
| Fédala.....                                   | 17                       | 7         | 11  | 14      |
| Casablanca.....                               | 11                       | 8         | 17  | 14      |
| Total saisonnier pour le secteur nord.....    | 99                       | 258       | 49  | 62.5    |
| <b>Secteur Central</b>                        |                          |           |     |         |
| Mazagan.....                                  | 19                       | 17        | 11  | 110     |
| Safi.....                                     | 1.25                     | 13        | 9   | 70      |
| Mogador.....                                  | 6                        | 96        | 6   | 20      |
| Total saisonnier pour le secteur central..... | 26.25                    | 126       | 26  | 200     |
| <b>Secteur Sud</b>                            |                          |           |     |         |
| Ghir.....                                     | 20                       | 50        | 36  | 168     |
| Agadir.....                                   | 1                        | 2         | 7   | 1       |
| O. Massa.....                                 | 5                        | 2         | —   | 17      |
| Ifni.....                                     | 9                        | 34        | 6   | 12      |
| O. Draa.....                                  | 35                       | 15        | 20  | 20      |
| Conception.....                               | 1                        | 14        | —   | —       |
| Puerto Cansado.....                           | 20                       | 48        | 11  | 27      |
| C. Juby.....                                  | 60                       | 10        | 40  | 10      |
| Total saisonnier pour le secteur sud.....     | 151                      | 175       | 120 | 255     |
| <b>Ensemble des Secteurs</b>                  |                          |           |     |         |
| Total pour chaque saison.....                 | 276.25                   | 559       | 195 | 517.5   |
| Total général.....                            | 1547.75 cm. <sup>3</sup> |           |     |         |

## I. Répartition saisonnière.

L'examen du tableau des analyses quantitatives pour 1950 nous amène aux constatations suivantes:

— Le plancton de l'hiver 1950 est moyennement abondant dans les 3 secteurs côtiers du nord, du centre et du sud.

Un refroidissement net par rapport à l'hiver précédent (poussée moins forte des eaux chaudes d'origine subtropicale) expliquerait la richesse moindre de l'hiver 1950.

— Le printemps présente une très grande richesse avec un maximum très marqué en face du Cap Spartel, une zone de concentration moindre à Mogador et un ensemble assez riche dans le secteur sud. Les formes planctoniques les plus abondantes en cette saison sont les Mysidacés, les Décapodes, les Cladocères.

— L'été est pauvre du nord au sud avec un seul maximum, celui des Salpes approximativement localisées dans le secteur central. La pauvreté de l'été se retrouve donc chaque année.

— En automne l'abondance du plancton redevient très grande avec une densité dominante dans tout le secteur central, depuis Mazagan jusqu'au Cap Ghir. L'automne apparaît ainsi comme une saison très riche, sinon la plus riche de l'année 1950 pendant laquelle de nombreuses formes planctoniques ont présenté leur maximum de concentration: les Diphyes, les Sagitta, les Copépodes, les Euphausiacés. La richesse automnale semble donc aussi constante que la pénurie estivale.

En résumé, l'année 1950 comprend un hiver d'abondance moyenne, un été pauvre et deux saisons très riches: le printemps et l'automne.

## II. Répartition géographique.

A) Le tableau précité indique la distribution géographique du zooplancton et permet d'évaluer la richesse respective des trois secteurs, nord, centre et sud de la zone marocaine.

En 1950, comme en 1949, la densité du plancton s'équilibre approximativement dans les 3 secteurs côtiers.

On ne relève donc pas, comme en 1947 et en 1948, d'opposition marquée entre des secteurs nord et sud riches, d'une part, et un secteur central pauvre, d'autre part.

B) Certaines modalités dans la répartition des indicateurs de plancton mettent en évidence les rapports étroits entre les migrations planctoniques et les modifications saisonnières de l'hydrologie côtière marocaine.

L'une des plus significatives, déjà observée en 1949, est l'existence anormale au voisinage de la côte, à certains moments, de formes

planctoniques de haute mer, telles que Diphyes, Oikopleura et Salpes organismes à peu près dénués de mouvements propres et donc soumis à ceux de leur habitat.

La venue à la côte et le retour au large de ces organismes coïncide avec l'envahissement de la zone côtière par les eaux transgressives puis avec leur retrait.

C) Cependant on n'observe pas en 1950 le déplacement saisonnier, particulièrement net en 1949, des zones de plus grande concentration de divers groupes indicateurs; ces zones passant du sud en hiver, au nord au printemps et en été, pour revenir vers le sud en automne.

La régularité de ce déplacement traduisait pour 1949 une intensité accrue des mouvements transgressifs et régressifs des masses océaniques. La poussée des eaux du large s'était en effet montrée remarquablement forte et précoce cette année-là.

Or en 1950 cette même poussée a été moins forte sinon moins précoce; ceci a entraîné, outre un abaissement général de la température, une atténuation des modifications hydrologiques saisonnières.

Ainsi à une situation hydrologique moins contrastée d'une saison à l'autre en 1950 a correspondu apparemment une répartition moins tranchée des organismes planctoniques.

A la fin de cette 4<sup>ème</sup> année d'étude nous pouvons résumer brièvement les faits principaux recueillis d'après l'examen d'un millier de prélèvements.

1°) Le zooplancton marocain est varié. Pour ne citer que quelques exemples, l'étude systématique encore partielle que nous avons effectuée a révélé la présence d'une douzaine d'espèces de Méduses, d'une dizaine d'espèces de Chaetognates, d'une quinzaine d'espèces de Pteropodes, d'autant de Mysidacés, etc...

2°) L'abondance saisonnière est très inégale. Deux saisons sont particulièrement riches: le printemps et surtout l'automne qui présente souvent le maximum de concentration. L'été, au contraire, est manifestement la saison la plus pauvre.

Quant à la richesse de l'hiver, elle est irrégulière, parfois très grande (1949), parfois moyenne (1950), parfois très faible (1947).

Ces fluctuations sont sous la dépendance des facteurs hydrologiques eux-mêmes variables d'une année à l'autre le long du littoral marocain.

3°) Les modifications saisonnières des conditions hydrologiques (température notamment) sur nos côtes déterminent des migrations planctoniques caractéristiques :

a) des déplacements en latitude, soit du sud vers le nord accompagnant la poussée des eaux chaudes au printemps et en été, soit du nord vers le sud suivant leur régression en automne.

Ces migrations du plancton sont apparentes surtout lorsque les mouvements océaniques sont de grande amplitude.

On observe alors un balancement régulier entre la richesse du secteur nord, celle du secteur central et celle du secteur sud qui sont tour à tour envahis et délaissés par les eaux de température favorable à la pullulation des éléments planctoniques.

b) des déplacements du large vers la côte et inversement affectant des formes de haute

mer (Diphyes, Oikopleura, Salpes) dont la venue momentanée à la côte coïncide avec l'envahissement de la zone côtière par les eaux transgressives et le retour au large avec leur régression.

Ainsi se trouve confirmé le rôle primordial du plancton en tant que détecteur biologique des phénomènes océaniques.

Ce sont là les résultats obtenus par une étude essentiellement quantitative des prélèvements.

Abandonnant le point de vue quantitatif, nous nous livrerons dans une prochaine note à l'étude biologique de plusieurs groupes indicateurs. Elle portera en premier lieu sur les Chaetognathes, puis sur les Mysidacés et enfin sur les Ptéropodes.

MARIE-LOUISE FAURE.

## LES POISSONS

### CLUPÉIDÉS

Sardine (*Clupea* = *Sardina pilchardus* WALB).

Oufs et Larves

récoltés en Manche occidentale.

L'examen des pêches de plancton<sup>1)</sup> faites au cours de la Campagne du «Président Théodore Tissier» du 26 au 28 Juin 1951, à 15/20 milles du nord-ouest au nord-est d'Ouessant, sur les pêcheries de sardines adultes, de 18 à 28 cm. de long (mode 24) (dites «coureuses»), âgées de 5 à 7 ans, n'a permis d'y trouver que de très rares œufs de sardines généralement isolés.

Cependant, trois larves de Clupéidés variant de 8 à 10 mm. de long ont été trouvées à la station 520 : (Lat. 48°42'; Long. 5°02).

<sup>1)</sup> Voir note planctonique, pp. 65 et 66.

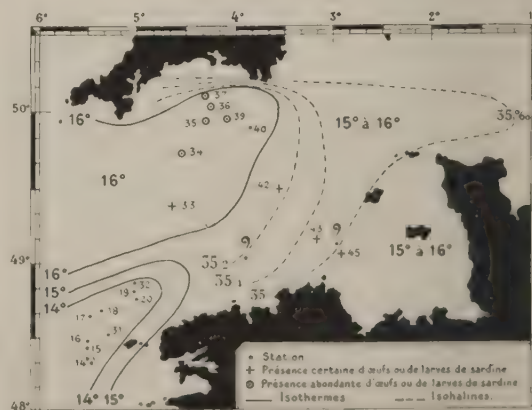


Figure 1.



Par contre, les pêches planctoniques faites un mois plus tard, du 24 au 26 Juillet 1951, contenaient des œufs et des larves de sardines plus ou moins abondants aux stations suivantes: 533 — 534 — 535 — 536 — 537 — 539 — 542 — 551 — 552 — 553 — 554 — 555 — 559 — 562 — 566 — 575 — 586 — 587.

Les œufs et les larves étaient particulièrement abondants dans les prélèvements effectués aux stations suivantes:

24 Juillet 1951, surface

Sn: 534      Sn: 537      Sn: 539  
L: 49°44'    L: 50°09'    L: 49°55'  
l: 4°32'     l: 4°17'     l: 4°

La mensuration des larves de Clupéidés trouvées dans ces 3 échantillons a donné les résultats suivants:

| Station | Minima<br>mm. | Maxima<br>mm. | Moyenne<br>mm. | Taille la plus<br>fréquente<br>mm. |
|---------|---------------|---------------|----------------|------------------------------------|
| 534     | 5             | 14            | 9.63           | 10                                 |
| 537     | 6             | 19            | 12.09          | 12                                 |
| 539     | 8             | 24            | 15.29          | 15                                 |

Des œufs et des larves de maquereau (*Scomber scombrus*) étaient aussi abondants dans ces parages.

Les stations marquées d'une (+) indiquent les stations où furent récoltés des œufs et des larves de sardines, abondants aux stations indiquées (○). Elle indique également les isothermes et isohalines de surface observées dans la région.

G. LEFÈVRE.

### Répartition des Concentrations dans le Golfe de Gascogne.

Le tableau de corrélation «Taille-Poids et Moule», publié dans les *Annales Biologiques* — Vol. VII, 1950, p. 50, dont l'exactitude a été contrôlée une fois de plus, permet d'évaluer rapidement, d'après le «Moule» des filets employés pour leur capture ou le «Nombre au kilogramme» des poissons débarqués, la longueur moyenne des sardines présentes dans

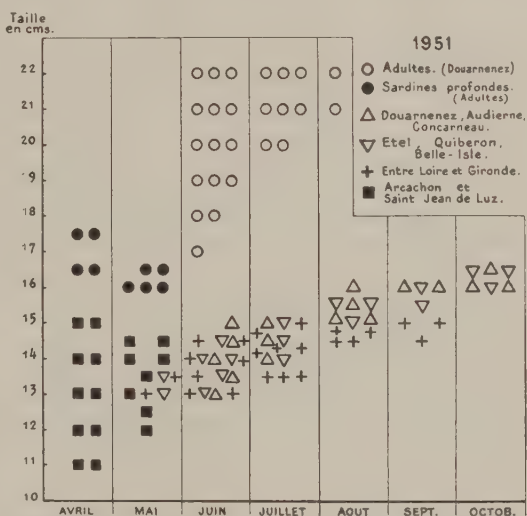


Figure 2. Longueur et croissance de la Sardine du Golfe de Gascogne pendant la saison de pêche (Avril—Octobre 1951).

Tableau 1. Sardines du Golfe de Gascogne. Longueur moyenne, 1951.

| Mois           | Douarnenez<br>Audierne   | Penmarch<br>Concarneau | Etel<br>Quiberon<br>Belle Isle | Entre Loire<br>et<br>Gironde | Arcachon | Saint-<br>Jean-de-<br>Luz |
|----------------|--------------------------|------------------------|--------------------------------|------------------------------|----------|---------------------------|
| Avril.....     | 17.5 (P)                 | —                      | —                              | —                            | 14/15    | 11 à 12                   |
| Mai.....       | 19/22 (C)<br>16-16.5 (P) | —                      | 13                             | 13/13.5                      | 13/14.5  | 12 à 12.5                 |
| Juin.....      | 19/22 (C)<br>13          | 14.5/15                | 14/14.5                        | 13.5/14<br>14.5              | —        | —                         |
| Juillet.....   | 19/22 (C)<br>14/15       | 14.5/15                | 14.5/15                        | 13.5/14<br>14.5              | —        | —                         |
| Août.....      | 15/16                    | 15/15.5                | 15/15.5                        | 14.5/15                      | —        | —                         |
| Septembre..... | 16                       | 16/16                  | 15.5/16                        | 14.5/15                      | —        | —                         |
| Octobre.....   | 16/16.5                  | 16-16.5                | 16/16.5                        | —                            | —        | —                         |

Longueurs en centimètres

P = Sardine profonde

C = Sardine coureuse. Adulte en période de ponte

(sans indication) Sardine dite de Rogue (généralement immature)

les concentrations, d'Avril à fin d'Octobre, et d'en suivre la croissance. (Tab. 1).

On peut en conclure que :

a) Dans chaque secteur considéré la longueur moyenne des sardines augmente progressivement de 13 à 14 cm. jusqu'à 16.5 cm. : Croissance moyenne de 2.5 cm. à 3 cm.

b) La longueur moyenne des sardines est pendant toute la saison de pêche d'autant plus grande que les concentrations sont plus septentrionales.

J. LE GALL.

### Observations effectuées dans le Golfe de Gascogne en 1951.

Au cours de l'année 1951 les observations sur la sardine ont été effectuées, d'une part en Août-Septembre à bord du navire «Président Théodore Tissier» dans tout le Golfe de Gascogne et, d'autre part, au laboratoire de La Rochelle de Juillet à Octobre.

#### I. Matériel recueilli dans l'ensemble du Golfe de Gascogne (Août et Sept.).

En Août-Septembre nous avons examiné 1146 sardines capturées dans les parties nord (Concarneau, Belle-Ile et Saint-Nazaire) et sud (Iles d'Yeu et d'Oléron, Arcachon et Vieux Boucaut) du Golfe de Gascogne.

#### Tailles et groupes.

La presque totalité du matériel recueilli a de 135 à 165 mm. de longueur totale et une taille modale de 140—145 mm. pour les échantillons capturés de l'Ile d'Yeu à la côte des Landes et de 150—155 mm. pour ceux pris le long de la côte de Bretagne entre Saint-Nazaire et Concarneau.

Ce n'est que dans la région de l'Ile d'Oléron que nous avons trouvé de petites sardines ayant de 95 à 130 mm. (mode 120 mm.). L'examen des écailles nous a montré que ces petites sardines appartenaient au groupe 0 et que l'on en retrouvait également quelques-unes devant Arcachon.

Quant aux individus ayant de 130 à 165 mm. ils appartenaient pratiquement tous au groupe I et se rencontraient dans toute la zone côtière du Golfe de Gascogne. Leur taille à  $L_1$  était relativement élevée puisqu'elle variait de 65 à 120 mm. avec mode à 90 ou 100 mm.

Les sardines du groupe II étaient très rares, d'une taille variant de 145 à 160 mm. elles ne

constituent que 2 % de notre matériel contre 3 % pour les sardines du groupe 0 et 95 % pour celles du groupe I.

#### Moyenne vertébrale.

La moyenne vertébrale des différents lots varie de 52.26 à 52.46 pour les individus du groupe I témoignant ainsi d'une population relativement homogène tout le long du littoral Atlantique. Les petites sardines du groupe 0 ont, par contre, une moyenne vertébrale nettement plus faible puisqu'elle n'est que de 51.88. Ce caractère permet de les séparer nettement quant à leur origine, des sardines du groupe I.

#### Examen de l'ensemble des résultats pour le groupe I.

L'ensemble de nos observations sur le groupe I est résumé, lot par lot, dans le tableau suivant :

| Origine     | Taille modale | Taille à $L_1$ | Moyenne vertébrale |
|-------------|---------------|----------------|--------------------|
| Concarneau  | 155 mm.       | 95 mm.         | 52.37 $\pm$ 0.182  |
| Belle-Ile   | 150           | 96             | 52.46 $\pm$ 0.319  |
| St-Nazaire  | 150           | 95             | 52.46 $\pm$ 0.319  |
| Moyenne =   | 150           | 95             | 52.41              |
| Ile d'Yeu   | 145 mm.       | 90 mm.         | 52.26 $\pm$ 0.168  |
| Oléron      | 140           | 89             | 52.36 $\pm$ 0.262  |
| Arcachon    | 145           | 91             | 52.31 $\pm$ 0.322  |
| Vx. Boucaut | 145           | 89             | 52.30 $\pm$ 0.333  |
| Moyenne =   | 145           | 90             | 52.31              |

Si ces résultats sont dans l'ensemble très homogènes on peut cependant noter une légère différence entre les sardines du nord et du sud du Golfe de Gascogne : la population du nord a une taille modale de 150 mm. contre 145 pour celle du sud, une taille à  $L_1$  de 95 mm. contre 90 et enfin une moyenne vertébrale de 52.41 contre 52.31.

Ces différences sont très peu sensibles mais leur répétition dans les trois caractères étudiés permet cependant d'y déceler deux pontes de fin d'année d'où ces sardines seraient issues.

Or, si l'on se réfère aux travaux publiés par FURNESTIN, par FOREST, et par nous mêmes, on constate que ces sardines sont caractéristiques de celles rencontrées en Août-Septembre dans la partie nord du Golfe de Gascogne tandis que dans la partie sud, au contraire, on rencontre habituellement des sardines issues de pontes de printemps et dont la taille à  $L_1$  est comprise entre 4 et 9 cm. En 1951 nous n'avons pratiquement pas rencontré

Tableau 2. Tailles observées.

| 1. Golfe de Gascogne |            |           |            |           |              |          |               | 2. La Rochelle |      |       |       |
|----------------------|------------|-----------|------------|-----------|--------------|----------|---------------|----------------|------|-------|-------|
| mm.                  | Concarneau | Belle-Ile | St-Nazaire | Ile d'Yeu | Ile d'Oléron | Arcachon | Vieux Boucaut | Juillet        | Août | Sept. | Oct.  |
| 85.....              | —          | —         | —          | —         | 0.6          | —        | —             | —              | —    | 0.5   | —     |
| 90.....              | —          | —         | —          | —         | —            | —        | —             | —              | —    | —     | —     |
| 95.....              | —          | —         | —          | —         | 0.3          | —        | —             | —              | —    | 0.5   | —     |
| 100.....             | —          | —         | —          | —         | 0.3          | —        | —             | 0.5            | —    | 0.5   | —     |
| 105.....             | —          | —         | —          | —         | 0.3          | —        | —             | 1              | 2    | 0.5   | —     |
| 110.....             | —          | —         | —          | —         | 1.6          | —        | —             | 18             | 32   | 1.5   | —     |
| 115.....             | —          | —         | —          | —         | 6.2          | —        | —             | 22.5           | 48   | 5     | —     |
| 120.....             | —          | —         | —          | —         | 6.7          | —        | —             | 2.5            | 14   | 5     | —     |
| 125.....             | —          | —         | —          | —         | 5.5          | —        | —             | 1              | 2    | 4.5   | 6     |
| 130.....             | —          | —         | —          | —         | 2.2          | —        | —             | 6.5            | —    | 3     | 2.5   |
| 135.....             | —          | —         | —          | —         | 8.3          | 2.5      | —             | 29             | —    | 10    | 12    |
| 140.....             | —          | —         | 1.4        | 12        | 28.6         | 11.4     | 28            | 18             | 1    | 32    | 29.5  |
| 145.....             | 0.6        | 5.3       | 29.6       | 62        | 28           | 46.8     | 50            | 1              | 1    | 27    | 35    |
| 150.....             | 13.2       | 61.1      | 50.3       | 24        | 9.2          | 35.2     | 20            | —              | —    | 8     | 13    |
| 155.....             | 52.5       | 31.8      | 16.8       | 2         | 1.6          | 2.5      | 2             | —              | —    | 1     | 2     |
| 160.....             | 27.5       | 1.8       | 1.9        | —         | 0.3          | 1.6      | —             | —              | —    | 0.5   | —     |
| 165.....             | 6.2        | —         | —          | —         | 0.3          | —        | —             | —              | —    | 0.5   | —     |
| t.....               | 100.0      | 100.0     | 100.0      | 100       | 100.0        | 100.0    | 100           | 100.0          | 100  | 100.0 | 100.0 |

ces individus à faible  $L_1$ . C'est ce que montre le tableau suivant:

Tailles à  $L_1$  observées en Août—Septembre:

| Observateur | FURNESTIN | LETA-<br>CONNOUX | FOREST     | LETA-<br>CONNOUX |
|-------------|-----------|------------------|------------|------------------|
| Région      | Landes    | La Rochelle      | Concarneau | Golfe            |
| Année       | 1941—42   | 1947             | 1948       | 1951             |
| mm. 40      | 0.5       | —                | —          | —                |
| 50          | 21        | 3.5              | —          | —                |
| 55          | —         | 14.2             | —          | —                |
| 60          | 26        | 16               | 1.7        | —                |
| 65          | —         | 22               | 2.7        | 0.2              |
| 70          | 25        | 14.8             | 1.3        | 0.2              |
| 75          | —         | 14               | 6.7        | 1.6              |
| 80          | 19        | 8.2              | 8.4        | 8.3              |
| 85          | —         | 5.8              | 12         | 16               |
| 90          | 5         | —                | 10.4       | 29.8             |
| 95          | —         | 1.5              | 13.8       | 16.5             |
| 100         | 2         | —                | 10.7       | 20               |
| 105         | —         | —                | 11.4       | 5.8              |
| 110         | 1         | —                | 9.8        | 0.7              |
| 115         | —         | —                | 4.7        | 0.2              |
| 120         | 0.5       | —                | 4.4        | 0.7              |
| 125         | —         | —                | 2          | —                |
| 130         | —         | —                | 0.6        | —                |
| t.          | 100.0     | 100.0            | 100.0      | 100.0            |

L'examen du matériel recueilli à bord du «Président Théodore Tissier» nous conduit donc à admettre qu'il n'y avait en Août—Septembre, sur toutes les pêcheries du Golfe de Gascogne, que des sardines du groupe I nées au cours de pontes de fin d'année et que les sardines du groupe 0 étaient très peu abondantes et d'une moyenne vertébrale très faible.

## 2. Matériel recueilli dans la région de La Rochelle.

Le matériel recueilli de Juillet à Octobre au cours de la saison de pêche dans la région

de La Rochelle confirme les observations précédentes.

### Tailles et groupes.

Deux groupes d'individus ont été observés parmi les 1115 sardines examinées au laboratoire de La Rochelle; le groupe 0 dont la taille modale est passée de 115 à 125 mm. au cours de la saison, le groupe I dont la taille modale a été de 135 à 145 mm.

### Taille à $L_1$ .

L'examen de la taille à  $L_1$  montre qu'au cours de l'année ce sont surtout les sardines

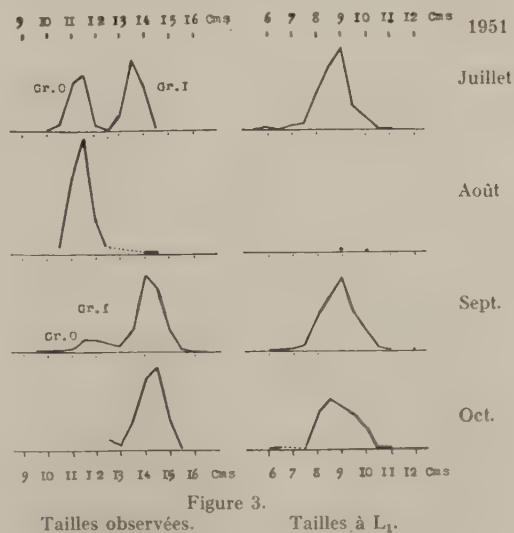
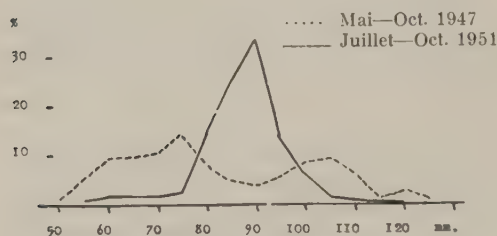




Tableau 3. Tailles à  $L_1$ .

| mm. | Con-carneau | Belle-Ile | St-Nazaire | Ile d'Yeu | Ile Oléron | Arcachon | Vieux Boucaut | Moyenne | Juil.  | Août | Sept. | Oct.  | Moyenne |
|-----|-------------|-----------|------------|-----------|------------|----------|---------------|---------|--------|------|-------|-------|---------|
| 55  | —           | —         | —          | —         | —          | —        | —             | —       | 0.5    | —    | —     | —     | 0.5     |
| 60  | —           | —         | —          | —         | —          | —        | —             | —       | 1      | —    | 1     | 0.5   | 1       |
| 65  | —           | —         | —          | —         | 1          | —        | —             | 0.2     | 0.5    | —    | 0.5   | 0.5   | 1       |
| 70  | —           | —         | —          | —         | —          | —        | 1             | 0.2     | 1.5    | —    | 1     | —     | 1       |
| 75  | 1           | —         | —          | 3         | —          | —        | 3             | 1.6     | 2      | —    | 2.5   | 0.5   | 2       |
| 80  | 4           | 2         | 2          | 5         | 12         | 3        | 7             | 8.3     | 15     | —    | 14    | 15.5  | 14.5    |
| 85  | 6           | —         | 4          | 10        | 18         | 12       | 17            | 16      | 27     | —    | 23    | 21.5  | 24      |
| 90  | 27          | 15        | 15         | 17        | 21         | 12       | 16            | 29.8    | 35     | 2    | 30.5  | 33.5  | 33      |
| 95  | 21          | 8         | 9          | 8         | 8          | 12       | 3             | 16.5    | 10     | —    | 15.5  | 15    | 13      |
| 100 | 30          | 17        | 15         | 4         | 9          | 7        | 2             | 20      | 6.5    | 1    | 9     | 9     | 7       |
| 105 | 10          | 5         | 4          | 2         | 2          | 1        | —             | 5.8     | 0.5    | —    | 2     | 2     | 1.5     |
| 110 | 1           | 2         | —          | —         | —          | —        | —             | 0.7     | 0.5    | —    | 0.5   | 2     | 1       |
| 115 | —           | —         | —          | 1         | —          | —        | —             | 0.2     | —      | —    | —     | —     | —       |
| 120 | —           | 1         | 1          | —         | —          | —        | 1             | 0.7     | —      | —    | 0.5   | —     | 0.5     |
| t.  | 100         | 50        | 50         | 50        | 71         | 47       | 50            | 100.0   | 100.0  | 3    | 100.0 | 100.0 | 100.0   |
|     |             |           |            |           |            |          |               |         | n. 216 | 3    | 166   | 147   | 532     |

Figure 4. Tailles à  $L_1$  en 1947 et 1951.

qui avaient de 75 à 105 mm. en fin d'hiver (mode à 90 mm.) qui constituent la quasi totalité du stock. Ce sont donc des sardines issues de pontes de fin d'année qui dominent au détriment des sardines de printemps.

## Moyenne vertébrale.

FURNESTIN a admis que les sardines du groupe 0 (et du groupe I à valeur élevée de  $L_1$ ) ont une moyenne vertébrale légèrement supérieure à celle du groupe I (vrai, à faible valeur de  $L_1$ ):

— Groupe 0  $52.27 \pm 0.04$ ; — Groupe I  $52.17 \pm 0.03$ .

En 1947, nous avons retrouvé dans la région de La Rochelle des valeurs extrêmement voisines:

— Groupe 0  $52.21 \pm 0.077$ ; — Groupe I  $52.11 \pm 0.106$ .

En 1951, ces données sont complètement changées, le groupe I ayant une moyenne vertébrale voisine de celle de l'ancien groupe

Tableau 4. Moyenne vertébrale.

## a) Golfe de Gascogne

| M. V.   | Concarneau | Belle-Ile | St-Nazaire | Groupe I  |              | Arcachon | Vieux Boucaut | Groupe 0 Oléron Arcachon |
|---------|------------|-----------|------------|-----------|--------------|----------|---------------|--------------------------|
|         |            |           |            | Ile d'Yeu | Ile d'Oléron |          |               |                          |
| 51..... | 3          | 4         | 2          | 4         | 8            | 4        | 6             | 8                        |
| 52..... | 57         | 20        | 26         | 29        | 45           | 27       | 24            | 22                       |
| 53..... | 40         | 25        | 19         | 17        | 24           | 18       | 19            | 4                        |
| 54..... | —          | 1         | 3          | —         | 3            | 1        | 1             | —                        |
| t.....  | 100        | 50        | 50         | 50        | 80           | 50       | 50            | 34                       |

## b) La Rochelle

| Gr.         | Juillet |       | Août  | Septembre |       | Octobre |       | Moyenne |       |
|-------------|---------|-------|-------|-----------|-------|---------|-------|---------|-------|
|             | 0       | I     | 0     | 0         | I     | 0       | I     | 0       | I     |
| M.V. 50.... | 1.2     | 0.5   | —     | —         | —     | —       | —     | 50      | 0.4   |
| 51.....     | 32.5    | 5.5   | 26.8  | 22.8      | 10.8  | 50      | 6.8   | 51      | 29.5  |
| 52.....     | 60.3    | 59    | 58.8  | 68.6      | 56.8  | 41.5    | 52.1  | 52      | 60.0  |
| 53.....     | 6.0     | 33    | 13.4  | 8.6       | 30.5  | 8.5     | 38.4  | 53      | 9.7   |
| 54.....     | —       | 2     | 1     | —         | 1.9   | —       | 2.7   | 54      | 0.4   |
|             | 100.0   | 100.0 | 100.0 | 100.0     | 100.0 | 100.0   | 100.0 | 100.0   | 100.0 |
| n.....      | 83      | 217   | 97    | 35        | 167   | 12      | 146   | 227     | 533   |
| moyenne...  | 51.71   | 52.30 | 51.92 | 51.85     | 52.23 | 51.58   | 52.36 | 51.80   | 52.30 |

0 et ce dernier ayant maintenant une moyenne nettement inférieure à celle du groupe I :

— Groupe 0  $51.80 \pm 0.139$ ; — Groupe I  $52.30 \pm 0.094$ .

Le travail de FURNESTIN ayant été poursuivi entre 1940 et 1943 et nos observations, qui sont mentionnées ici, à La Rochelle en 1947, il apparaît donc que les données recueillies dans ces travaux ont été valables pendant sept ans au moins; mais que depuis cette dernière date, de profondes modifications sont intervenues dans l'écologie de la sardine du Golfe de Gascogne. L'apparition d'un groupe 0 à faible moyenne vertébrale est à noter tout particulièrement car cette moyenne est parfaitement comparable à celle observée en 1950, par FERNANDEZ et NAVARRO dans la région de Santander, et qui varie de 51.88 à 51.95.

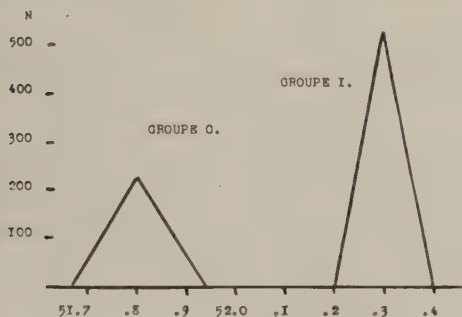


Figure 5. Triangles de fluctuation de la moyenne vertébrale des groupes 0 et I.

### 3. Conclusion.

Les observations effectuées en 1951 permettent de constater que dans le Golfe de Gascogne :

1°. Les sardines du groupe I, issues de pontes de printemps et caractérisées par une faible taille à  $L_1$  et une moyenne vertébrale de 52.10 environ ont été pratiquement absentes.

2°. Seules des sardines provenant de pontes de fin d'année étaient présentes de Juillet à Octobre 1951 sur les pêcheries. Elles étaient caractérisées par une taille à  $L_1$  variant de 75 à 105 mm. (modes 90—95 mm.) et par une moyenne vertébrale qui, de la côte des Landes à l'Île d'Yeu, était de 52.30 et de Saint-Nazaire à Concarneau, de 52.40.

3°. Le groupe 0 caractérisé d'ordinaire par une moyenne vertébrale de 52.20 à 52.30 et originaire de la partie nord du Golfe de Gascogne a été remplacé par un groupe 0 ayant une

moyenne vertébrale de 51.80 analogue à celle donnée pour la région de Santander. Ce groupe n'a été présent en abondance sur les pêcheries du sud du Golfe qu'au milieu de l'été.

R. LETACONNOUX.

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LETACONNOUX, 1950. Etude préliminaire de la Sardine du secteur de La Rochelle. Cons. Intern. Explor. Mer, Rapp. et Proc.-Verb., 126, p. 68.

### La Sardine de la Côte Basque en 1951.

Les observations ont porté sur huit échantillons de 100 poissons, prélevés dans les pêches au filet tournant. Les lots proviennent du fond du Golfe de Gascogne, près de Saint-Sébastien et au large de la côte française, excepté ceux du 30 Août et du 12 Septembre, pêchés bien plus à l'ouest, au large de Santurce (près de Bilbao; observateur le Dr. CUESTA) et de Laredo (province de Santander); il faudrait donc les rapprocher des échantillons étudiés à Santander à la même date.

La répartition des tailles, ramenées au demi-centimètre inférieur, est donnée au Tableau 5, où font contraste la petitesse des sardines

Tableau 5. Répartition des tailles.

| Taille | 22/1 | 3/2 | 1/3 | 5/4 | 20/6 | 5/7 | 30/8 | 12/9 |
|--------|------|-----|-----|-----|------|-----|------|------|
| 90     | 1    | —   | —   | —   | —    | —   | —    | —    |
| 95     | 8    | —   | —   | —   | —    | —   | —    | —    |
| 100    | 45   | —   | —   | —   | —    | —   | —    | —    |
| 105    | 29   | 1   | —   | 1   | —    | —   | —    | —    |
| 110    | 10   | 2   | 6   | 1   | —    | —   | —    | —    |
| 115    | 4    | 1   | 25  | 3   | —    | —   | —    | —    |
| 120    | —    | 11  | 24  | 6   | —    | —   | —    | —    |
| 125    | 1    | 24  | 25  | 15  | —    | —   | —    | —    |
| 130    | —    | 19  | 14  | 12  | 8    | —   | —    | —    |
| 135    | 2    | 18  | 3   | 12  | 34   | —   | —    | —    |
| 140    | —    | 14  | —   | 12  | 33   | 10  | —    | —    |
| 145    | —    | 6   | 2   | 4   | 13   | 43  | —    | —    |
| 150    | —    | 1   | —   | 9   | 5    | 36  | —    | —    |
| 155    | —    | 1   | 1   | 7   | 4    | 10  | 2    | —    |
| 160    | —    | —   | —   | 6   | 1    | —   | 15   | 13   |
| 165    | —    | —   | —   | 5   | —    | —   | 31   | 45   |
| 170    | —    | —   | —   | 4   | 2    | 1   | 27   | 27   |
| 175    | —    | —   | —   | 3   | —    | —   | 15   | 12   |
| 180    | —    | —   | —   | —   | —    | —   | 3    | 3    |
| 185    | —    | —   | —   | —   | —    | —   | 6    | —    |
| 190    | —    | —   | —   | —   | —    | —   | 1    | —    |
| N.     | 100  | 100 | 100 | 100 | 100  | 100 | 100  | 100  |
| Moy.   | 103  | 131 | 122 | 140 | 146  | 148 | 170  | 167  |

prélevées en Janvier et la grande taille moyenne des échantillons d'Août et de Septembre, étrangers à la population basque, comme nous venons de le signaler. La présence en hiver de petites sardines, à taille moyenne de 10 cm., est un fait souvent constaté dans cette région. Le matériel restant est de taille normale; la croissance des valeurs moyennes est de deux centimètres environ dans la période Février-Juillet.

#### Caractères sexuels.

Les sardines étudiées le 5 Avril étaient en grande majorité des poissons au stade IV de maturation, avec quelques-uns au stade V. Toutes les sardines prélevées à la mi-Juin étaient au stade VIII. La ponte s'est effectuée en Avril-Mai. Les grosses sardines de l'ouest prélevées en Août et Septembre ont déjà repris la maturation et les poissons au stade III ne sont pas rares.

Sur 368 sardines dont le sexe a été précisé, 217 (59 %) étaient de femelles et 151 de mâles (41 %). Cette proportion est sensiblement normale.

#### Formule vertébrale.

Comme l'indiquent les chiffres portés dans le Tableau 6, la formule vertébrale est à peu près invariable pour le matériel prélevé de

Tableau 6. Formule vertébrale.

| Date/N.V. | 50 | 51 | 52 | 53 | 54 | N.  | M ± FI     |
|-----------|----|----|----|----|----|-----|------------|
| 22/1      | —  | 29 | 57 | 13 | 1  | 100 | 51.86 0.22 |
| 3/2       | —  | 28 | 48 | 23 | 1  | 100 | 51.97 0.25 |
| 1/3       | —  | 30 | 48 | 22 | —  | 100 | 51.92 0.24 |
| 5/4       | —  | 29 | 46 | 25 | —  | 100 | 51.96 0.25 |
| 20/6      | —  | 26 | 54 | 20 | —  | 100 | 51.94 0.23 |
| 5/7       | —  | 31 | 42 | 27 | —  | 100 | 51.96 0.26 |
| 30/8      | 2  | 15 | 47 | 36 | —  | 100 | 52.17 0.25 |
| 18/9      | 1  | 16 | 45 | 35 | 3  | 100 | 52.23 0.26 |

Février à Juillet. Par contre, la valeur moyenne du premier lot (Janvier) est plus basse et elle est plus forte pour les sardines de l'ouest. Elle est de 52.00 pour l'ensemble (N = 800) et de 51.935 pour la sardine provenant du fond du Golfe (N = 600). Adoptons ce dernier chiffre pour la comparaison avec les données obtenues auparavant à St-Sébastien :

|              |           |
|--------------|-----------|
| 1944 = 51.94 | (N = 795) |
| 1948 = 51.96 | (N = 200) |
| 1949 = 51.96 | (N = 100) |
| 1951 = 51.93 | (N = 600) |

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#### La Sardine de Santander en 1951.

Quatorze lots de 100 sardines ont été étudiés d'Avril à Décembre; ils proviennent des pêches à la rogue au filet tournant, excepté l'échantillon du 4 Avril, pêché sans rogue.

Tableau 7. Répartition des tailles, Santander.

| Date   | 4/4 | 13/4 | 12/6 | 27/6 | 23/7 | 6/8 | 21/8 | 28/8 | 6/9 | 15/9 | 27/9 | 8/10 | 15/11 | 11/12 |
|--------|-----|------|------|------|------|-----|------|------|-----|------|------|------|-------|-------|
| Taille |     |      |      |      |      |     |      |      |     |      |      |      |       |       |
| 100    | 1   | —    | —    | —    | —    | —   | —    | —    | —   | —    | —    | —    | —     | —     |
| 105    | 8   | —    | —    | —    | —    | —   | —    | —    | —   | —    | —    | —    | —     | —     |
| 110    | 38  | —    | —    | —    | —    | —   | —    | —    | —   | —    | —    | —    | —     | —     |
| 115    | 28  | —    | —    | —    | —    | —   | —    | —    | —   | —    | —    | —    | —     | —     |
| 120    | 18  | —    | —    | —    | —    | —   | —    | —    | —   | —    | —    | —    | —     | —     |
| 125    | 6   | —    | —    | —    | —    | —   | —    | —    | —   | —    | —    | —    | —     | —     |
| 130    | 1   | 2    | —    | —    | —    | —   | —    | —    | —   | —    | —    | —    | —     | —     |
| 135    | —   | 10   | 7    | —    | —    | —   | —    | —    | —   | —    | —    | 1    | —     | —     |
| 140    | —   | 27   | 27   | 2    | —    | —   | —    | —    | —   | —    | —    | —    | —     | —     |
| 145    | —   | 23   | 13   | 4    | —    | —   | —    | —    | —   | —    | —    | —    | —     | —     |
| 150    | —   | 21   | 11   | 13   | 11   | —   | —    | —    | —   | —    | —    | —    | —     | —     |
| 155    | —   | 9    | 15   | 24   | 35   | 1   | —    | 1    | 2   | 4    | —    | 1    | —     | 1     |
| 160    | —   | 6    | 15   | 30   | 37   | 6   | 10   | 8    | 9   | 5    | —    | —    | —     | —     |
| 165    | —   | —    | 8    | 18   | 15   | 28  | 30   | 26   | 36  | 28   | 4    | 7    | —     | 3     |
| 170    | —   | 1    | 4    | 7    | 2    | 34  | 42   | 37   | 42  | 43   | 13   | 43   | 15    | 11    |
| 175    | —   | —    | —    | 2    | —    | 17  | 15   | 20   | 7   | 18   | 40   | 27   | 29    | 25    |
| 180    | —   | 1    | —    | —    | —    | 8   | 2    | 6    | 4   | 2    | 28   | 10   | 29    | 35    |
| 185    | —   | —    | —    | —    | —    | 5   | 1    | 2    | —   | —    | 10   | 4    | 16    | 15    |
| 190    | —   | —    | —    | —    | —    | —   | —    | —    | —   | —    | 4    | 2    | 5     | 3     |
| 195    | —   | —    | —    | —    | —    | 1   | —    | —    | —   | —    | 1    | —    | 4     | 3     |
| 200    | —   | —    | —    | —    | —    | —   | —    | —    | —   | —    | —    | 1    | 1     | 3     |
| 205    | —   | —    | —    | —    | —    | —   | —    | —    | —   | —    | —    | —    | —     | —     |
| 210    | —   | —    | —    | —    | —    | —   | —    | —    | —   | —    | —    | —    | —     | 1     |
| N.     | 100 | 100  | 100  | 100  | 100  | 100 | 100  | 100  | 100 | 100  | 100  | 96   | 100   | 100   |
| Moy.   | 114 | 146  | 150  | 158  | 158  | 170 | 169  | 169  | 168 | 169  | 177  | 172  | 179   | 179   |



Tableau 8. Caractères sexuels.

| Date  | Femelles |      | Mâles |      | Maturité |    |     |    |    |    |     |      | Poids, gr. |       |
|-------|----------|------|-------|------|----------|----|-----|----|----|----|-----|------|------------|-------|
|       | N        | T.M. | N     | T.M. | I        | II | III | IV | V  | VI | VII | VIII | Ov.        | Test. |
| 13/4  | 43       | 148  | 57    | 144  | 3        | 7  | 1   | —  | 6  | 49 | 21  | 13   | 0.73       | 0.63  |
| 12/6  | 69       | 149  | 31    | 150  | —        | —  | —   | —  | 3  | 28 | 60  | 9    | 0.34       | 0.57  |
| 27/6  | 54       | 157  | 46    | 159  | 14       | 53 | 1   | 1  | 1  | 1  | 29  | —    | 0.14       | 0.13  |
| 23/7  | 71       | 158  | 29    | 158  | 6        | 3  | —   | —  | —  | —  | 91  | —    | 0.09       | 0.10  |
| 6/8   | 66       | 170  | 34    | 170  | —        | 4  | —   | 1  | —  | —  | 95  | —    | 0.19       | 0.14  |
| 21/8  | 55       | 169  | 45    | 167  | —        | —  | —   | —  | —  | 2  | 98  | —    | 0.20       | 0.08  |
| 28/8  | 47       | 169  | 53    | 168  | —        | —  | —   | —  | —  | —  | 100 | —    | 0.24       | 0.12  |
| 6/9   | 42       | 168  | 58    | 167  | —        | 89 | 11  | —  | —  | —  | —   | —    | 0.20       | 0.10  |
| 15/9  | 48       | 169  | 52    | 169  | —        | 48 | 52  | —  | —  | —  | —   | —    | 0.31       | 0.14  |
| 27/9  | 64       | 178  | 36    | 174  | —        | —  | 70  | 30 | —  | —  | —   | —    | 0.66       | 0.66  |
| 8/10  | 39       | 175  | 57    | 171  | —        | 6  | 1   | 14 | 60 | 18 | 1   | —    | 1.38       | 0.88  |
| 15/11 | 48       | 181  | 52    | 177  | —        | —  | 1   | 18 | 39 | 42 | —   | —    | 2.29       | 1.70  |
| 11/12 | 78       | 180  | 22    | 175  | —        | —  | —   | —  | 89 | 11 | —   | —    | 1.88       | 2.01  |

N = 724

572

Comme d'habitude, les apports ont été très faibles en hiver et nous ne disposons pas de matériel pour cette période.

#### Répartition des tailles.

Les tailles ont été mesurées au millimètre et ramenées au demi-centimètre le plus voisin. Leur fréquence dans les échantillons est donnée dans le Tableau 7.

On remarquera tout d'abord que le premier lot (4 Avril) contraste par sa petite taille moyenne (11.5 cm.); peut-être le procédé de pêche en est-il la cause, mais il faut rappeler que la présence en automne/hiver de petites sardines a été parfois constatée à Santander: on peut supposer qu'elles sont nées hors de la saison normale de ponte. Dès mi-Avril le matériel est devenu homogène, semblant appartenir à un seul groupe d'âge, dont la taille moyenne s'accroît vite en printemps et en été et plus lentement en automne, de 14.5 cm. jusqu'à 18 cm. Le même phénomène s'est produit en 1949 et 1950 (voir Ann. Biol. VI et VII).

#### Caractères sexuels.

La répartition des sexes et la taille moyenne des mâles et des femelles pour les divers lots sont portées dans le Tableau 8. Pour l'ensemble, le nombre des femelles excède celui des mâles, le pourcentage respectif étant 55.9 et 44.1. De même, il y a presque toujours une petite différence de taille à l'avantage des femelles; plus grosses sont les sardines, plus fort est cet écart.

Nos observations sur l'évolution sexuelle (Tableau 8), comportant l'appréciation empirique de la maturité et le poids moyen des

glandes sexuelles à chaque date, ne nous permettent pas de suivre le cycle entier par suite du manque de matériel d'hiver.

En Avril, les stades VI et VII prédominent, mais un certain pourcentage d'individus reste encore aux premiers stades. En mi-Juin le stade VII est prédominant, la ponte étant entièrement accomplie à la fin de ce mois. En Septembre la maturation est amorcée à nouveau et avance vite dans la suite, en sorte que les sardines les plus précoces seront peut-être en frai vers la fin de Novembre. Les données pondérales sont aussi remarquablement expressives de l'évolution; cependant nous ignorons encore pour chaque taille le poids maximum des gonades prêtes à la ponte.

Les pêches planctoniques au large de Santander ont attesté la présence d'œufs de sardine du début Mars à la fin Juillet 1951 (Observation du Dr. CUESTA).

#### Formule vertébrale.

Comme l'indiquent les chiffres exposés au Tableau 9, la moyenne vertébrale des divers

Tableau 9. Formule vertébrale.

| Date  | 50 | 51  | 52  | 53  | 54 | N    | M ± Fl     |
|-------|----|-----|-----|-----|----|------|------------|
| 13/4  | —  | 35  | 51  | 12  | 1  | 99   | 51.79 0.23 |
| 12/6  | —  | 7   | 65  | 25  | 3  | 100  | 52.24 0.21 |
| 27/6  | —  | 10  | 67  | 23  | —  | 100  | 52.13 0.19 |
| 23/7  | —  | 10  | 63  | 27  | —  | 100  | 52.17 0.19 |
| 6/8   | —  | 3   | 63  | 32  | 2  | 100  | 52.33 0.19 |
| 21/8  | —  | 13  | 54  | 30  | 3  | 100  | 52.23 0.24 |
| 28/8  | —  | 22  | 58  | 19  | 1  | 100  | 51.99 0.23 |
| 6/9   | —  | 17  | 57  | 25  | 1  | 100  | 52.10 0.23 |
| 15/9  | —  | 10  | 58  | 30  | 2  | 100  | 52.24 0.22 |
| 27/9  | —  | 17  | 59  | 22  | 2  | 100  | 52.09 0.23 |
| 8/10  | —  | 20  | 54  | 18  | 4  | 96   | 52.06 0.26 |
| 15/11 | —  | 12  | 51  | 34  | 3  | 100  | 52.28 0.24 |
| 11/12 | 2  | 14  | 57  | 25  | 2  | 100  | 52.11 0.23 |
| Total | 2  | 190 | 757 | 322 | 24 | 1295 | 52.14 0.06 |

lots oscille dans de limites étroites, entre 51.79 et 52.33. La chute estivale constatée en 1949 et 1950 ne s'est pas produite en 1951. En conséquence, la valeur moyenne absolue s'est rehaussée et normalisée:

|                      |                             |
|----------------------|-----------------------------|
| 1940—1944.....       | 52.18 $\pm$ 0.05 (N = 2290) |
| hiver 1947—1948..... | 51.90 $\pm$ 0.13 (N = 429)  |
| 1948—1949.....       | 51.78 $\pm$ 0.07 (N = 1047) |
| 1950.....            | 51.77 (N = 805)             |
| 1951.....            | 52.14 $\pm$ 0.06 (N = 1925) |

Dans le présent matériel il n'y a d'autre anomalie que la basse valeur moyenne correspondant à l'échantillon du 13 Avril. Celle du dernier lot étudié en 1950 (le 25 Août) était 51.53.

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### La Sardine de Malaga.

Deux problèmes particuliers ont surtout fait l'objet des recherches en 1951. D'abord, nous avons tâché d'établir en hiver le cycle de la maturation sexuelle. Puis, en Septembre-Octobre, sur un matériel très homogène, nous avons centré les études sur la corrélation entre la taille et le nombre des vertèbres. En conséquence, les échantillons ont été souvent «choisis» et l'ensemble du matériel ne donne pas une fidèle représentation de la population.

En ce qui concerne la *répartition des tailles* (Tableau 10) deux faits, déjà bien connus sont constatés à nouveau:

a) En hiver, la courbe des fréquences est bimodale (13.5 et 16.5 cm.), représentant deux groupes d'âge séparés;

b) Le renouvellement de la population s'est produit en été par suite de l'apparition d'un nouveau groupe de jeunes; l'incorporation de ces petites sardines se prolonge durant plusieurs mois.

Les petites sardines du 7 Décembre étaient mélangées avec des allaches, un peu plus petites encore.

### Caractères sexuels.

Le Tableau 11 montre que les femelles sont plus nombreuses que les mâles: 70.5 et 29.5 % respectivement; cette disproportion est bien plus forte que d'habitude. La taille moyenne des femelles surpasse faiblement celle des mâles, mais pas toujours.

En ce qui concerne la maturité sexuelle empirique, les chiffres portés dans le Tableau 11 montrent que la ponte était déjà commencée le 21 Décembre, et qu'elle n'avait pas fini le 16 Février. Mais c'est entre le 11 Janvier et le 2 Février que les sardines au stade VI sont prédominantes.

Tableau 10. Fréquence des tailles (%), Malaga.

| Taille | 1950 |       |      |      |      |     | 1951 |     |      |       |      |      |
|--------|------|-------|------|------|------|-----|------|-----|------|-------|------|------|
|        | 11/9 | 21/12 | 11/1 | 17/1 | 23/1 | 2/2 | 16/2 | 7/6 | 16/8 | Sept. | Oct. | 7/12 |
| 85     | —    | —     | —    | —    | —    | —   | —    | —   | —    | —     | 0.3  | —    |
| 90     | —    | —     | —    | —    | —    | —   | —    | —   | —    | 0.1   | 0.3  | —    |
| 95     | —    | —     | —    | —    | —    | —   | —    | —   | —    | 0.5   | 0.3  | —    |
| 100    | —    | —     | —    | —    | —    | —   | —    | 2   | —    | 0.5   | 0.3  | 32.5 |
| 105    | —    | —     | —    | —    | —    | —   | —    | 11  | —    | 1.6   | 0.7  | 17.5 |
| 110    | —    | —     | —    | —    | —    | —   | —    | 26  | —    | 2.8   | 3.3  | 20.0 |
| 115    | —    | —     | —    | —    | —    | —   | —    | 44  | —    | 9.8   | 2.0  | 7.5  |
| 120    | —    | —     | 6    | 1    | —    | 3   | 2    | 12  | —    | 21.5  | 12.3 | 7.5  |
| 125    | 13   | 7     | 2    | 5    | 4    | 6   | —    | 4   | —    | 35.5  | 28.7 | 7.5  |
| 130    | 34   | 27    | 3    | 15   | 27   | 25  | 12   | 1   | 11   | 22.6  | 35.3 | 7.5  |
| 135    | 33   | 32    | 3    | 37   | 35   | 30  | 21   | —   | 29   | 4.4   | 12.7 | —    |
| 140    | 14   | 21    | 3    | 23   | 22   | 21  | 17   | —   | 34   | 0.6   | 3.7  | —    |
| 145    | 5    | 6     | 6    | 13   | 8    | 8   | 12   | —   | 10   | 0.1   | —    | —    |
| 150    | 1    | 5     | 11   | 3    | 2    | 3   | 11   | —   | 10   | —     | —    | —    |
| 155    | —    | —     | 13   | —    | 1    | —   | 5    | —   | —    | —     | —    | —    |
| 160    | —    | 1     | 18   | —    | 1    | 2   | 3    | —   | —    | —     | —    | —    |
| 165    | —    | 1     | 20   | —    | —    | 1   | 7    | —   | —    | —     | —    | —    |
| 170    | —    | —     | 8    | —    | —    | 1   | 3    | —   | —    | —     | —    | —    |
| 175    | —    | —     | 4    | 1    | —    | —   | 5    | —   | —    | —     | —    | —    |
| 180    | —    | —     | 2    | —    | —    | —   | 2    | —   | —    | —     | —    | —    |
| 185    | —    | —     | 1    | 1    | —    | —   | —    | —   | —    | —     | —    | —    |
| 190    | —    | —     | 1    | 1    | —    | —   | —    | —   | —    | —     | —    | —    |
| N      | 100  | 100   | 100  | 100  | 100  | 100 | 100  | 100 | 100  | 800   | 300  | 40   |
| T. M.  | 135  | 137   | 157  | 140  | 138  | 138 | 148  | 115 | 141  | 125   | 129  | 112  |

Tableau 11. Caractères sexuels.

| Date  | Femelles |       | Mâles |       | Maturité empirique (%) |    |     |    |    |    |     |      |
|-------|----------|-------|-------|-------|------------------------|----|-----|----|----|----|-----|------|
|       | N        | T. M. | N     | T. M. | I                      | II | III | IV | V  | VI | VII | VIII |
| 1950  |          |       |       |       |                        |    |     |    |    |    |     |      |
| 11/9  | 55       | 135   | 41    | 135   | 100                    | —  | —   | —  | —  | —  | —   | —    |
| 21/12 | 76       | 136   | 13    | 140   | —                      | —  | 9   | 10 | 36 | 27 | —   | 18   |
| 1951  |          |       |       |       |                        |    |     |    |    |    |     |      |
| 11/1  | 63       | 160   | 30    | 153   | —                      | —  | —   | —  | 4  | 55 | 29  | 12   |
| 17/1  | 74       | 141   | 23    | 136   | —                      | —  | —   | 2  | 14 | 73 | 3   | 8    |
| 23/1  | 90       | 138   | 9     | 138   | —                      | —  | 1   | 4  | 3  | 64 | 8   | 10   |
| 2/2   | 54       | 139   | 46    | 136   | —                      | —  | —   | —  | 6  | 59 | 12  | 23   |
| 16/2  | 58       | 145   | 32    | 152   | —                      | —  | —   | —  | —  | 14 | 28  | 58   |
| 16/8  | 66       | 141   | 33    | 142   | —                      | —  | —   | —  | —  | —  | —   | —    |
| 30/10 | 57       | 130   | 21    | 127   | —                      | —  | —   | —  | —  | —  | —   | —    |

T. M. = taille moyenne, mm.

Les données sur le poids des gonades (Tableau 12) confirment les observations empiriques. Pourtant, il faut remarquer que les valeurs moyennes pour le lot du 16 Février représentent les gonades aux stades VI et VII, celles du stade VIII exclues.

Le matériel étudié en été et en automne était vierge ou à sexe imprécis. Parmi les petites sardines du 7 Décembre quelques-unes étaient mûres ou à peu près.

**Formule vertébrale.**

A notre avis, l'interprétation des résultats portés dans le Tableau 13 n'est pas malaisée. Elle vient à l'appui des opinions formulées par nous depuis longtemps sur la variabilité de la formule vertébrale et sur l'âge et la croissance de la sardine méditerranéenne.

On peut remarquer :

a) Que la moyenne vertébrale pour les sept premiers lots (Septembre 1950—Février 1951) est relativement faible, excepté celle du 11 Janvier.

Tableau 13. Formule vertébrale.

| Date  | 50 | 51 | 52 | 53 | N   | M ± FI       |
|-------|----|----|----|----|-----|--------------|
| 1950  |    |    |    |    |     |              |
| 11/9  | 8  | 58 | 33 | 1  | 100 | 51.27 ± 0.21 |
| 21/12 | 12 | 61 | 27 | —  | 100 | 51.15 ± 0.20 |
| 1951  |    |    |    |    |     |              |
| 11/1  | 6  | 51 | 42 | 1  | 100 | 51.38 ± 0.21 |
| 17/1  | 9  | 67 | 24 | —  | 100 | 51.15 ± 0.19 |
| 23/1  | 6  | 70 | 24 | —  | 100 | 51.18 ± 0.17 |
| 2/2   | 9  | 60 | 28 | 3  | 100 | 51.25 ± 0.22 |
| 11/2  | 9  | 73 | 17 | 1  | 100 | 51.10 ± 0.18 |
| 7/6   | 9  | 52 | 38 | 1  | 100 | 51.31 ± 0.22 |
| 16/8  | 3  | 55 | 40 | 2  | 100 | 51.41 ± 0.20 |
| 3/9   | 3  | 60 | 37 | —  | 100 | 51.34 ± 0.18 |
| 8/9   | 3  | 50 | 45 | 2  | 100 | 51.46 ± 0.20 |
| 12/9  | —  | 61 | 37 | 2  | 100 | 51.41 ± 0.18 |
| 17/9  | —  | 52 | 44 | 4  | 100 | 51.52 ± 0.19 |
| 20/9  | 8  | 43 | 47 | 2  | 100 | 51.43 ± 0.22 |
| 22/9  | 2  | 55 | 41 | 2  | 100 | 51.43 ± 0.22 |
| 25/9  | 5  | 51 | 43 | 1  | 100 | 51.40 ± 0.20 |
| 28/9  | 3  | 55 | 42 | —  | 100 | 51.39 ± 0.18 |
| 3/10  | 4  | 53 | 40 | 3  | 100 | 51.42 ± 0.21 |
| 13/10 | 7  | 48 | 44 | 1  | 100 | 51.39 ± 0.21 |
| 30/10 | 6  | 57 | 37 | —  | 100 | 51.31 ± 0.19 |
| 7/12  | 5  | 26 | 9  | —  | 40  | 51.10 ± 0.31 |

Tableau 12. Poids moyen des gonades (g.). (1950—51).

| Taille | Ovaires |      |      |       |     |       | Testicules |      |       |       |     |       |
|--------|---------|------|------|-------|-----|-------|------------|------|-------|-------|-----|-------|
|        | 21/12   | 11/1 | 17/1 | 23/1  | 2/2 | 16/2  | 21/12      | 11/1 | 17/1  | 23/1  | 2/2 | 16/2  |
| 120    | —       | —    | —    | —     | —   | 0.4 * | —          | —    | —     | —     | —   | 0.9   |
| 125    | 0.5     | —    | 1.0  | 0.3 * | —   | —     | 0.7        | —    | 1.1   | 0.2 * | 0.8 | —     |
| 130    | —       | —    | —    | —     | 0.9 | 0.7   | 0.7        | —    | —     | —     | 1.1 | —     |
| 135    | 0.8     | —    | 0.9  | 1.0   | 1.0 | 0.6   | —          | —    | 1.5   | 0.9   | 1.1 | —     |
| 140    | 0.9     | —    | 1.2  | —     | 1.1 | 0.8   | 1.7        | —    | —     | —     | 1.0 | 0.4 * |
| 145    | —       | 1.3  | —    | 1.0   | 0.6 | 0.6   | —          | 1.0  | 1.3   | 0.4   | 1.0 | —     |
| 150    | 0.2     | —    | —    | —     | —   | 1.2 * | 0.7        | —    | 0.2 * | —     | 0.6 | —     |
| 155    | —       | —    | —    | 1.4   | —   | 0.3   | —          | —    | —     | 0.2   | —   | 0.2   |
| 160    | —       | —    | —    | —     | 1.5 | 0.1   | —          | —    | —     | —     | —   | —     |
| 165    | —       | —    | —    | —     | —   | 0.1   | —          | —    | —     | —     | —   | 0.6   |
| 170    | —       | —    | 1.8  | —     | —   | 1.5 * | —          | 0.7  | —     | —     | —   | —     |
| 175    | —       | 1.3  | —    | —     | —   | 3.0   | —          | —    | —     | —     | —   | 0.1   |
| 180    | —       | —    | —    | —     | —   | 0.4 * | —          | —    | —     | —     | —   | 0.1 * |

\* Une sardine seulement.



b) Qu'elle se rehausse dans la suite et se maintient remarquablement stable, excepté celle du dernier échantillon (7 Décembre).

Les sardines du premier groupe appartiennent en majorité à la génération de l'hiver 1949—50; cependant, dans le lot du 11 Janvier, à moyenne 51.38, prédominent les individus nés l'hiver 1948—49, dont la moyenne était 51.36 (N = 380) (voir Ann. Biol. VI). Cet échantillon écarté, la valeur moyenne correspondant à la génération 1949—50 devient 51.18 (N = 600).

La population représentée par le deuxième groupe (dès le mois de Juin) est née dans la saison 1950—51. La valeur moyenne pour les quatorze échantillons étudiés (N = 1340) est 51.38; les moyennes partielles oscillent dans des limites étroites, surtout en Septembre-Octobre. Font exception les petites sardines du 7 Décembre, dont la moyenne tombe à 51.10, peut-être à cause de ce qu'elles proviennent de ponte tardive, du printemps, effectuée au sein d'eaux réchauffées; en tout cas, leur petit nombre enlève la signification statistique de la valeur moyenne.

Le coefficient de corrélation entre la taille et le nombre des vertèbres a été calculé par quinzaines sur un matériel très homogène quant à la taille et peut-être quant à la date de naissance.

Les valeurs du coefficient et des erreurs sont:

|                 |                        |
|-----------------|------------------------|
| 3—12 Septembre  | = + 0.17 ( $\pm$ 0.05) |
| 17—28 Septembre | = + 0.17 ( $\pm$ 0.04) |
| 3—10 Octobre    | = + 0.09 ( $\pm$ 0.07) |

Bien que la corrélation soit toujours positive et que sa valeur ne soit pas trop petite dans les deux premiers cas, les erreurs standard nous semblent trop fortes; il devient sage de s'abstenir de conclure en définitive.

EMMA BARDAN et F. NAVARRO.

### La Sardine de Majorque en 1951.

L'importance industrielle de la sardine est insignifiante aux Baléares. Cependant, certains procédés de pêche étant licites aux îles, les biologistes peuvent récolter des données dont l'acquisition devient impossible ailleurs. Cela concerne surtout la possibilité d'étudier les alevins et les jeunes.

Nous avons pu nous procurer du matériel provenant:

a) des pêches des «artets», petits filets trainants maniés d'un canot au port de Palma, ne dépassant pas dix mètres en profondeur;

b) des pêches des «camiones», petits filets tournants pêchant dans la nuit à l'aide de lampes à pétrole;

c) des pêches au «farol» (au feu), procédé de pêche nocturne au filet tournant («traina»); tandis que les «camiones» sont utilisés à l'entrée du port ou tout près des rivages de la baie par des profondeurs inférieures à 20 ou 25 mètres, les «trainas» pêchent plus loin de la côte, au centre de la baie, dans l'embouchure ou au large, sur fonds de 40 à 100 mètres;

Tableau 14. Fréquence des tailles (‰), Majorque. Adultes.

| Date                | N.  | Taille en cm. |      |      |      |      |      |      |      |      |     | Moy. |
|---------------------|-----|---------------|------|------|------|------|------|------|------|------|-----|------|
|                     |     | 12            | 13   | 14   | 15   | 16   | 17   | 18   | 19   | 20   | 21  |      |
| 6/1 <sup>1)</sup>   | 104 | —             | 1.0  | 4.8  | 12.5 | 23.0 | 30.8 | 23.9 | 2.0  | 2.0  | —   | 16.7 |
| 16/1 <sup>1)</sup>  | 100 | —             | 1.0  | 2.0  | 3.0  | 7.0  | 9.0  | 35.0 | 26.0 | 15.0 | 3.0 | 18.1 |
| 19/1 <sup>1)</sup>  | 100 | —             | —    | 4.0  | 13.0 | 23.0 | 38.0 | 16.0 | 5.0  | 1.0  | —   | 16.6 |
| 31/1 <sup>1)</sup>  | 85  | —             | —    | 1.2  | 8.2  | 5.9  | 24.7 | 31.7 | 16.5 | 9.4  | 2.4 | 17.9 |
| 2/2 <sup>1)</sup>   | 100 | 6.0           | 10.0 | 28.0 | 29.0 | 20.0 | 4.0  | 1.0  | 2.0  | —    | —   | 14.7 |
| 15/2 <sup>1)</sup>  | 93  | 1.0           | 2.1  | 14.0 | 18.3 | 18.3 | 21.5 | 15.1 | 5.4  | 4.3  | —   | 16.1 |
| 12/6 <sup>2)</sup>  | 93  | —             | —    | 7.5  | 31.2 | 45.2 | 16.1 | —    | —    | —    | —   | 15.7 |
| 26/6 <sup>2)</sup>  | 100 | —             | —    | —    | 2.0  | 25.0 | 51.0 | 18.0 | 4.0  | —    | —   | 16.9 |
| 5/7 <sup>2)</sup>   | 38  | —             | —    | 13.2 | 36.8 | 47.4 | 2.6  | —    | —    | —    | —   | 15.3 |
| 14/7 <sup>2)</sup>  | 100 | —             | —    | —    | —    | 21.0 | 68.0 | 11.0 | —    | —    | —   | 16.8 |
| 24/8 <sup>1)</sup>  | 123 | —             | 2.4  | 13.0 | 36.6 | 26.8 | 18.7 | 2.4  | —    | —    | —   | 15.4 |
| 28/8 <sup>1)</sup>  | 127 | 5.5           | 13.4 | 8.6  | 35.4 | 25.2 | 9.5  | 2.4  | —    | —    | —   | 14.9 |
| 24/10 <sup>2)</sup> | 100 | —             | —    | —    | —    | 6.0  | 20.0 | 47.0 | 23.0 | 4.0  | —   | 17.9 |
| 30/10 <sup>2)</sup> | 114 | —             | 1.8  | 12.3 | 17.5 | 7.9  | 21.0 | 26.3 | 13.1 | —    | —   | 16.7 |
| 5/11 <sup>2)</sup>  | 100 | —             | —    | 6.0  | 4.0  | 3.0  | 25.0 | 43.0 | 15.0 | 4.0  | —   | 17.4 |
| 1/12 <sup>1)</sup>  | 111 | —             | —    | 9.0  | 10.8 | 3.6  | 18.0 | 32.4 | 21.6 | 4.5  | —   | 17.4 |
| 6/12 <sup>1)</sup>  | 110 | —             | —    | 6.3  | 7.2  | 11.8 | 30.0 | 33.7 | 8.2  | 2.7  | —   | 17.0 |
| 12/12 <sup>1)</sup> | 128 | —             | 3.9  | 19.5 | 13.3 | 10.1 | 21.1 | 17.2 | 11.7 | 3.1  | —   | 16.3 |

<sup>1)</sup> Pêches au chalut au large.

<sup>2)</sup> Pêches au feu au large.

d) enfin, des pêches au chalut («bous» et «vacas») faites le plus souvent hors de la baie, sur fonds de 100 mètres et davantage.

Les «artets» pêchent en hiver et en printemps larves et alevins de sardines mesurant de 3 à 7 ou 8 cm., parfois jusqu'à 11 cm. Les lots de «camion» sont formés par des sardinettes de 5 à 12 cm. Cette dernière taille atteinte, les sardines s'éloignent de la côte; alors elles sont pêchées «au feu», mélangées parfois de sardines plus âgées. Le chalutage est pratiqué toute l'année; dans les échantillons de cette provenance, le plus souvent hétérogènes, la dispersion des tailles devient très grande. Aucun des engins mentionnés n'est sélectif.

La répartition des tailles dans notre matériel est portée dans les Tableaux 14 et 15. Les tailles ont été mesurées au millimètre, mais pour simplifier ces tableaux elles ont été raménées au centimètre le plus voisin.

Il nous semble que ces deux tableaux sont riches en informations sur la biologie de la

sardine; mais, pour l'instant il suffit de faire ressortir trois circonstances:

1. La taille moyenne des sardines, au bout de la première année de vie, est de 12 à 14 cm., peut-être davantage pour celles nées de ponte précoce.

2. Dans les échantillons les plus «purs» d'alevins et de jeunes, à courbe des fréquences des tailles en cloche, dont l'allure élimine le soupçon d'un mélange de bandes d'âge différent, tout petit qu'il soit, la dispersion des tailles est néanmoins de 5 cm. environ, ce qui révèle d'assez grandes différences individuelles dans le rythme de croissance; cette dispersion, logiquement, doit persister dans les bandes d'adultes issus d'une même ponte.

3. Les courbes des fréquences de quelques lots de sardines adultes sont bimodales et l'écart entre les modes est de 3 ou 4 cm.; il nous semble que cet écart représente la croissance de la sardine durant sa deuxième année.

Tableau 15. Fréquence des tailles (‰). Classe 0.

|                    |     | Taille en cm. |      |      |      |      |      |      |      |      |      |     |      |
|--------------------|-----|---------------|------|------|------|------|------|------|------|------|------|-----|------|
| Date               | N   | 3             | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 11   | 12   | 13  | Moy. |
| 20/4               | 99  | —             | —    | 5.0  | 12.0 | 39.0 | 36.0 | 6.0  | 2.0  | —    | —    | —   | 7.3  |
| 1/5                | 68  | —             | —    | —    | 2.9  | 20.5 | 35.2 | 31.6 | 8.8  | 1.4  | —    | —   | 8.2  |
| 9/5                | 59  | —             | —    | —    | —    | 1.8  | 12.3 | 17.6 | 43.8 | 22.8 | 1.8  | —   | 9.9  |
| 14/5 <sup>1)</sup> | 137 | 38.7          | 51.9 | 7.4  | 1.4  | 0.7  | —    | —    | —    | —    | —    | —   | 3.7  |
| 14/5               | 100 | —             | —    | —    | —    | 23.0 | 59.0 | 17.0 | 1.0  | —    | —    | —   | 7.9  |
| 28/5 <sup>1)</sup> | 150 | 4.7           | 80.0 | 10.0 | 1.4  | 1.4  | 0.7  | —    | —    | —    | —    | —   | 3.9  |
| 31/5 <sup>1)</sup> | 62  | —             | —    | 22.6 | 22.5 | 37.0 | 17.8 | —    | —    | —    | —    | —   | 6.4  |
| 1/6 <sup>1)</sup>  | 149 | 0.7           | 76.3 | 13.5 | 4.0  | 4.1  | 0.7  | —    | 0.7  | —    | —    | —   | 4.3  |
| 6/6 <sup>1)</sup>  | 100 | —             | 86.0 | 9.0  | 4.0  | 1.0  | —    | —    | —    | —    | —    | —   | 4.1  |
| 13/6 <sup>1)</sup> | 82  | —             | —    | 1.2  | 35.4 | 59.8 | 3.6  | —    | —    | —    | —    | —   | 6.6  |
| 16/6               | 100 | —             | —    | —    | —    | —    | —    | 5.0  | 43.0 | 50.0 | 2.0  | —   | 10.4 |
| 20/6               | 100 | —             | —    | —    | —    | 2.0  | 5.0  | 46.0 | 43.0 | 4.0  | —    | —   | 9.4  |
| 25/6               | 130 | —             | —    | —    | —    | —    | 23.1 | 51.5 | 18.4 | 5.3  | 1.6  | —   | 9.0  |
| 26/6               | 52  | —             | —    | —    | —    | —    | 3.8  | 11.6 | 23.1 | 57.6 | 3.8  | —   | 10.4 |
| 28/6 <sup>1)</sup> | 199 | —             | 0.5  | 3.5  | 25.0 | 16.5 | 31.0 | 14.5 | 5.5  | 3.0  | —    | —   | 7.5  |
| 4/7                | 100 | —             | —    | —    | —    | 2.0  | 33.0 | 44.0 | 16.0 | 5.0  | —    | —   | 8.9  |
| 10/7               | 99  | —             | —    | —    | —    | —    | 7.0  | 28.0 | 50.0 | 15.0 | —    | —   | 9.7  |
| 12/7               | 100 | —             | —    | —    | —    | —    | —    | 13.0 | 63.0 | 24.0 | —    | —   | 10.1 |
| 17/7               | 200 | —             | —    | —    | —    | 1.0  | 46.5 | 48.5 | 4.0  | —    | —    | —   | 8.5  |
| 20/7               | 100 | —             | —    | —    | —    | —    | 18.0 | 68.0 | 12.0 | 2.0  | —    | —   | 8.9  |
| 26/7               | 205 | —             | —    | —    | —    | 1.9  | 18.8 | 48.3 | 29.2 | 1.9  | —    | —   | 9.1  |
| 3/8                | 150 | —             | —    | —    | —    | 4.7  | 18.0 | 46.7 | 30.0 | 0.7  | —    | —   | 9.0  |
| 7/8                | 215 | —             | —    | —    | —    | 3.2  | 23.8 | 53.0 | 19.0 | 0.9  | —    | —   | 8.8  |
| 13/8               | 149 | —             | —    | —    | —    | —    | —    | 2.7  | 61.7 | 34.9 | 0.7  | —   | 10.3 |
| 14/8               | 141 | —             | —    | —    | —    | —    | —    | 5.0  | 63.8 | 31.2 | —    | —   | 10.2 |
| 27/8               | 151 | —             | —    | —    | —    | 2.0  | 21.9 | 45.0 | 31.1 | —    | —    | —   | 9.0  |
| 30/8               | 95  | —             | —    | —    | —    | —    | —    | —    | —    | 41.1 | 57.9 | 1.0 | 11.6 |
| 1/9                | 155 | —             | —    | —    | —    | —    | 14.2 | 48.4 | 36.8 | 0.6  | —    | —   | 9.2  |
| 4/9                | 100 | —             | —    | —    | —    | —    | —    | —    | 59.0 | 41.0 | —    | —   | 10.4 |
| 11/9               | 154 | —             | —    | —    | —    | 0.6  | 15.5 | 28.5 | 24.0 | 27.3 | 3.8  | —   | 9.6  |
| 21/9               | 123 | —             | —    | —    | —    | —    | —    | 3.3  | 51.2 | 45.5 | —    | —   | 10.3 |
| 25/9               | 100 | —             | —    | —    | —    | —    | 3.0  | 24.0 | 58.0 | 15.0 | —    | —   | 9.8  |
| 9/10               | 111 | —             | —    | —    | —    | —    | —    | 5.4  | 10.8 | 65.8 | 18.0 | —   | 10.9 |

<sup>1)</sup> Pêches au filet traînant dans le port.

**Tableau 16. Caractères sexuels.**

| Date  | ♀♀   | N   | T. M. |     | Maturité (%) |    |     |    |    |    |     |      |
|-------|------|-----|-------|-----|--------------|----|-----|----|----|----|-----|------|
|       |      |     | ♂♂    | ♀♀  | I            | II | III | IV | V  | VI | VII | VIII |
| 6/1   | 71   | 32  | 170   | 159 | —            | —  | 18  | 33 | 26 | 18 | 2   | 3    |
| 16/1  | 58   | 42  | 184   | 178 | —            | —  | 14  | 26 | 22 | 28 | 7   | 3    |
| 19/1  | 49   | 49  | 170   | 162 | —            | —  | 5   | 25 | 39 | 22 | 9   | —    |
| 31/1  | 64   | 21  | 179   | 168 | —            | —  | 19  | 31 | 30 | 11 | 5   | 4    |
| 2/2   | 52   | 45  | 152   | 142 | —            | —  | 37  | 26 | 10 | 11 | —   | 16   |
| 15/2  | 41   | 49  | 165   | 160 | —            | —  | 13  | 28 | 23 | 7  | —   | 29   |
| 12/6  | 50   | 42  | 157   | 156 | 24           | 75 | —   | —  | —  | —  | —   | —    |
| 26/6  | 62   | 36  | 169   | 168 | 35           | 65 | —   | —  | —  | —  | —   | —    |
| 14/7  | 75   | 22  | 169   | 167 | —            | 99 | 1   | —  | —  | —  | —   | —    |
| 24/8  | 73   | 35  | 156   | 155 | 32           | 66 | 2   | —  | —  | —  | —   | —    |
| 28/8  | 52   | 52  | 152   | 154 | 45           | 55 | —   | —  | —  | —  | —   | —    |
| 24/10 | 50   | 49  | 181   | 178 | —            | 18 | 60  | 17 | 4  | 1  | —   | —    |
| 30/10 | 51   | 61  | 176   | 161 | 2            | 11 | 45  | 36 | 6  | —  | —   | —    |
| 5/11  | 71   | 26  | 178   | 170 | —            | 11 | 37  | 46 | 6  | —  | —   | —    |
| 1/12  | 61   | 50  | 180   | 164 | —            | —  | 27  | 51 | 14 | 7  | 1   | —    |
| 6/12  | 78   | 32  | 170   | 171 | —            | —  | 25  | 63 | 10 | 2  | —   | —    |
| 12/12 | 69   | 57  | 163   | 164 | —            | 2  | 12  | 32 | 25 | 18 | 11  | —    |
| Total | 1027 | 700 |       |     |              |    |     |    |    |    |     |      |

**Tableau 17. Poids moyen des gonades (g.).**

| Taille            | 1950              | 1951              |                   |                   |                   |                   |                   |                   |                   |
|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
|                   | 17/11             | 6/1               | 16/1              | 19/1              | 31/1              | 2/2               | 15/2              | 14/10             | 5/11              |
| <b>Ovaires</b>    |                   |                   |                   |                   |                   |                   |                   |                   |                   |
| 130.....          | —                 | —                 | —                 | —                 | —                 | 0.1               | 0.1               | —                 | —                 |
| 135.....          | —                 | 1.0               | —                 | —                 | —                 | 0.1               | 0.1               | —                 | 0.2 <sup>1)</sup> |
| 140.....          | —                 | 0.4 <sup>1)</sup> | —                 | —                 | —                 | 0.1               | 0.1               | —                 | 0.5 <sup>1)</sup> |
| 145.....          | —                 | 0.7               | —                 | —                 | —                 | 0.2 <sup>1)</sup> | 0.2 <sup>1)</sup> | —                 | —                 |
| 150.....          | 1.0               | 1.4               | 0.6               | 0.7               | 0.3               | 0.4               | 0.2               | —                 | 0.8               |
| 155.....          | 1.1               | 1.5               | 0.6               | 1.1               | 0.2 <sup>1)</sup> | 0.7               | 0.3               | 0.3               | —                 |
| 160.....          | 1.0               | 0.9               | 1.0               | 1.3               | 1.0 <sup>1)</sup> | 0.9               | 0.3               | 0.3 <sup>1)</sup> | 0.6               |
| 165.....          | 1.4               | 1.1               | 2.3 <sup>1)</sup> | 1.2               | 1.5               | 0.8               | 0.5               | 0.2 <sup>1)</sup> | 1.5               |
| 170.....          | 1.7               | 1.4               | 0.7               | 1.9               | 1.1               | 1.6               | 1.2               | 0.4               | 1.2               |
| 175.....          | 1.8               | 1.7               | 1.5               | 1.7               | 1.2               | —                 | 1.6               | 0.6               | 1.1               |
| 180.....          | 1.0 <sup>1)</sup> | 2.0               | 1.3               | 1.5               | 1.0               | 0.7 <sup>1)</sup> | 0.5               | 0.7               | 1.6               |
| 185.....          | 2.8               | 2.7 <sup>1)</sup> | 1.6               | 2.3 <sup>1)</sup> | 2.6               | 1.7               | 2.5               | 1.0               | 2.1               |
| 190.....          | 5.5 <sup>1)</sup> | 2.4 <sup>1)</sup> | 1.7               | 1.7               | 2.3               | —                 | —                 | 1.1               | 1.7               |
| 195.....          | 4.0               | 1.5 <sup>1)</sup> | 1.8               | 3.2 <sup>1)</sup> | 1.9               | —                 | 2.0               | 0.9               | 3.1               |
| 200.....          | —                 | 0.5 <sup>1)</sup> | 2.2               | —                 | 1.4 <sup>1)</sup> | —                 | —                 | 0.9               | 3.3 <sup>1)</sup> |
| 205.....          | —                 | —                 | 1.2               | —                 | 3.1               | —                 | —                 | —                 | —                 |
| 210.....          | —                 | —                 | 1.1 <sup>1)</sup> | —                 | —                 | —                 | —                 | —                 | —                 |
| <b>Testicules</b> |                   |                   |                   |                   |                   |                   |                   |                   |                   |
| 130.....          | —                 | 0.2 <sup>1)</sup> | 0.4               | —                 | —                 | —                 | —                 | —                 | —                 |
| 135.....          | —                 | 0.3 <sup>1)</sup> | —                 | 0.5               | 0.1 <sup>1)</sup> | 0.1               | 0.1               | —                 | —                 |
| 140.....          | —                 | 0.7               | 0.7               | 0.7               | —                 | 0.1               | 0.1               | —                 | 0.2               |
| 145.....          | 0.8               | 0.6               | 0.7 <sup>1)</sup> | 0.5               | 0.4               | 0.3               | 0.2               | —                 | 0.5 <sup>1)</sup> |
| 150.....          | 1.0               | 0.8               | 0.8 <sup>1)</sup> | 0.7               | 0.2               | 0.4               | 0.3               | —                 | 0.5 <sup>1)</sup> |
| 155.....          | 0.4               | 0.9               | —                 | 0.6               | 0.4 <sup>1)</sup> | 0.4 <sup>1)</sup> | 0.4               | —                 | —                 |
| 160.....          | 1.7 <sup>1)</sup> | 1.1               | 0.9               | 0.9               | 0.2               | 0.4 <sup>1)</sup> | 0.6               | 0.6               | 0.5 <sup>1)</sup> |
| 165.....          | 1.1               | —                 | 1.4               | 1.2               | —                 | —                 | 0.7               | 0.5               | 0.8               |
| 170.....          | 1.9 <sup>1)</sup> | 1.3               | 1.3               | 1.1               | 0.7               | —                 | 1.3               | 0.6               | 0.8               |
| 175.....          | 1.7               | 1.3               | 1.3               | 1.2               | 1.5               | —                 | 1.0               | 0.8               | 1.0               |
| 180.....          | 1.8 <sup>1)</sup> | 1.5               | 1.1               | 1.1 <sup>1)</sup> | 1.6               | —                 | 1.0               | 0.8               | 1.4               |
| 185.....          | 2.0 <sup>1)</sup> | —                 | 1.8               | 2.2 <sup>1)</sup> | 1.7 <sup>1)</sup> | —                 | —                 | 0.9               | 1.9               |
| 190.....          | —                 | —                 | 1.4               | 2.3 <sup>1)</sup> | 0.4 <sup>1)</sup> | —                 | 1.3 <sup>1)</sup> | 1.6               | —                 |
| 195.....          | —                 | —                 | 2.1               | —                 | 0.6 <sup>1)</sup> | —                 | —                 | —                 | 3.0 <sup>1)</sup> |
| 200.....          | —                 | —                 | 2.6               | —                 | —                 | —                 | —                 | —                 | —                 |

<sup>1)</sup> Valeurs correspondantes à une seule sardine.



Tableau 18. Formule vertébrale (Adultes).

| Dates | 49 | 50 | 51  | 52  | 53 | N    | M $\pm$ Fl |
|-------|----|----|-----|-----|----|------|------------|
| 31/1  | —  | 3  | 33  | 44  | 4  | 84   | 51.58 0.24 |
| 2/2   | 1  | 7  | 38  | 49  | 2  | 97   | 51.45 0.24 |
| 15/2  | —  | 4  | 38  | 46  | 5  | 93   | 51.56 0.22 |
| 12/6  | —  | 1  | 47  | 41  | 2  | 91   | 51.48 0.20 |
| 26/6  | —  | 1  | 43  | 53  | 3  | 100  | 51.58 0.19 |
| 14/7  | —  | 4  | 42  | 51  | 3  | 100  | 51.53 0.21 |
| 24/8  | —  | 3  | 43  | 72  | 5  | 123  | 51.64 0.17 |
| 28/8  | 1  | 13 | 43  | 56  | 6  | 119  | 51.45 0.24 |
| 24/10 | —  | 1  | 27  | 66  | 5  | 99   | 51.76 0.19 |
| 30/10 | —  | 1  | 38  | 69  | 6  | 114  | 51.70 0.18 |
| 5/11  | —  | 2  | 47  | 41  | 3  | 93   | 51.48 0.21 |
| 1/12  | —  | 3  | 48  | 58  | 2  | 111  | 51.53 0.19 |
| 6/12  | —  | 3  | 38  | 60  | 9  | 110  | 51.68 0.21 |
| 12/12 | —  | 3  | 38  | 75  | 12 | 128  | 51.75 0.19 |
| Total | 2  | 49 | 563 | 781 | 67 | 1462 | 51.66 0.06 |

## Caractères sexuels.

Comme d'habitude, les femelles sont plus abondantes que les mâles (59.5 et 40.5 % respectivement) et ceux-ci sont plus petits que celles-là (voir Tableau 16).

Les données déduites de l'observation empirique et de la pesée des gonades (Tableau 16 et 17) décèlent la grande irrégularité du cycle individuel de maturation sexuelle. La ponte était commencée en Novembre 1950, elle n'était pas achevée le 15 Février 1951. A la fin d'Octobre 1951 la maturation des glandes sexuelles est reprise; en Décembre, peut-être en Novembre, la ponte recommence.

## Formule vertébrale.

Les chiffres présentés dans les Tableaux 18 et 19 méritent quelques commentaires, intéressant surtout les sardines de la classe 0. Pour celles-ci, à l'intervalle d'un mois seulement, pour deux échantillons à taille moyenne à peine différente (20 Juin et 20 Juillet, 94 et 89 mm. respectivement), nous avons trouvé les valeurs extrêmes de notre série:  $51.72 \pm 0.20$  et  $51.32 \pm 0.22$ ; c'est-à-dire, un écart équivalent au support des «races» de sardines prétendues par divers investigateurs. Evidemment, ces sardinettes sont nées dans la région et appartiennent à une même génération; une autre proposition deviendrait absurde.

Nous avons poussé le problème des variations de la formule vertébrale et nous ne trouvons pas encore l'interprétation adéquate. La corrélation taille—vertèbres, qui veut dire la corrélation date de naissance—vertèbres, a été calculée pour nos sardinettes de Palma, groupées par dates les plus rapprochées possible.

Tableau 19. Formule vertébrale (Classe 0).

| Dates | 49 | 50 | 51  | 52   | 53 | N    | M $\pm$ Fl |
|-------|----|----|-----|------|----|------|------------|
| 16/6  | —  | 3  | 31  | 61   | 5  | 100  | 51.68 0.21 |
| 20/6  | —  | 2  | 27  | 63   | 4  | 96   | 51.72 0.20 |
| 4/7   | —  | 7  | 42  | 47   | 2  | 98   | 51.45 0.22 |
| 20/7  | —  | 7  | 54  | 34   | 2  | 97   | 51.32 0.22 |
| 26/7  | —  | 18 | 90  | 83   | 10 | 201  | 51.42 0.17 |
| 3/8   | —  | 5  | 45  | 62   | 2  | 114  | 51.54 0.19 |
| 7/8   | 2  | 13 | 75  | 112  | 4  | 206  | 51.50 0.16 |
| 13/8  | —  | 1  | 60  | 81   | 6  | 148  | 51.62 0.18 |
| 14/8  | —  | 1  | 52  | 82   | 6  | 141  | 51.66 0.16 |
| 27/8  | —  | 4  | 56  | 81   | 9  | 150  | 51.63 0.18 |
| 30/8  | —  | 1  | 28  | 45   | 6  | 80   | 51.70 0.23 |
| 1/9   | —  | 5  | 39  | 45   | 6  | 95   | 51.55 0.24 |
| 4/9   | —  | 1  | 35  | 56   | 4  | 96   | 51.66 0.20 |
| 11/9  | —  | 2  | 46  | 47   | 4  | 99   | 51.54 0.21 |
| 21/9  | —  | 7  | 43  | 52   | 6  | 108  | 51.53 0.23 |
| 25/9  | —  | 6  | 47  | 41   | 4  | 98   | 51.44 0.23 |
| 9/10  | —  | 2  | 38  | 51   | 6  | 97   | 51.63 0.22 |
| Total | 2  | 85 | 808 | 1043 | 86 | 2024 | 51.56 0.05 |

Les résultats (valeurs du coefficient de corrélation et de leurs erreurs standard) sont:

|                       |                         |
|-----------------------|-------------------------|
| 16 et 20 Juin         | = + 0.07 ( $\pm$ 0.07)  |
| 4 Juillet             | = + 0.37 ( $\pm$ 0.09)  |
| 20 et 26 Juillet      | = + 0.08 ( $\pm$ 0.06)  |
| 3 et 7 Août           | = - 0.07 ( $\pm$ 0.06)  |
| 13 et 14 Août         | = + 0.13 ( $\pm$ 0.06)  |
| 27 Août               | = - 0.08 ( $\pm$ 0.08)  |
| 30 Août, 1 et 4 Sept. | = + 0.08 ( $\pm$ 0.06)  |
| 11, 21 et 25 Sept.    | = + 0.002 ( $\pm$ 0.06) |

Excepté pour le lot du 4 Juillet, il nous semble que les résultats n'ont pas de valeur statistique. Cependant, il faut rappeler ce que nous avons insinué auparavant: que les différences des tailles dans les lots ne sont pas dérivées de la date de naissance, mais du taux de croissance individuelle.

Les fluctuations de la moyenne vertébrale sont plus petites chez les adultes: maximum 51.76; minimum 51.45.

Pour mieux servir les propos des *Annales Biologiques*, nous donnerons la formule vertébrale de la sardine de Majorque au cours des quatre dernières années:

|                        |                               |
|------------------------|-------------------------------|
| Hiver 1947—48, adultes | = $51.51 \pm 0.11$ (N = 315)  |
| Hiver 1948—49, adultes | = $51.54 \pm 0.14$ (N = 237)  |
| Novembre 1950, adultes | = $51.51 \pm 0.26$ (N = 97)   |
| 1951, classe 0         | = $51.56 \pm 0.05$ (N = 2024) |
| 1951, adultes          | = $51.66 \pm 0.06$ (N = 1462) |

Compte-tenu des valeurs de Fl., on peut soutenir l'invariabilité de la formule vertébrale. Cependant, ce sont l'étude et l'analyse des échantillons isolés qui posent et résolvent les problèmes.

M. OLIVER et F. NAVARRO.

## L'Influence des Variations de la Température sur les Migrations des Sardines au Maroc.

Dans mes recherches sur la sardine j'ai toujours insisté sur le fait, plusieurs fois mis en évidence, que parmi les facteurs de milieu déterminants de sa biologie la température est le plus important.

Aux différents stades évolutifs de la sardine correspondent des températures différentes: relativement élevées pour les larves et les jeunes, basses pour les adultes, modérées pour les individus en cours de reproduction.

Il en résulte que des sardines à un stade donné, se tenant dans des eaux d'une température donnée, seront chassées de leur secteur si la température vient brusquement à varier.

Un exemple précis tiré d'observations récentes soulignera cette influence de la température sur le comportement de l'espèce et la rapidité avec laquelle les variations de ce facteur déclenchent des migrations.

En général les sardines adultes de la région d'Agadir se rassemblent dès l'automne entre le Cap Ghir et l'Oued Massa, dans les eaux à 18°, pour se livrer à la ponte qui durera jusqu'au printemps. C'est ce rassemblement que les pêcheurs locaux exploitent activement en fin de saison.

Or au cours de l'automne 1950 les reproducteurs n'étaient pas au rendez-vous; en revanche la baie d'Agadir était abondamment peuplée d'immatures.

Des mesures répétées de la température de l'eau de mer et une recherche méthodique des bancs de sardines au moyen du sondeur à ultra-sons nous renseignèrent bientôt sur cette anomalie.

Toute la baie d'Agadir *sensu lato* était occupée par des eaux à plus de 20° favorables aux jeunes mais trop chaudes pour les reproducteurs. Ces derniers avaient migré à 100 milles plus au sud, entre Ifni et le Cap Juby, dans une zone où régnait une température voisine de 18°, donc favorable à la ponte.

Puis en Décembre et Janvier les eaux chaudes de la Baie furent très rapidement remplacées par des eaux à moins de 16° issues de la profondeur.

Cette température trop basse, aussi bien pour des adultes en cours de reproduction que pour des immatures, ne permit pas aux premiers de regagner la Baie et en chassa les seconds, transformant ainsi en désert toute une zone habituellement surpeuplée.

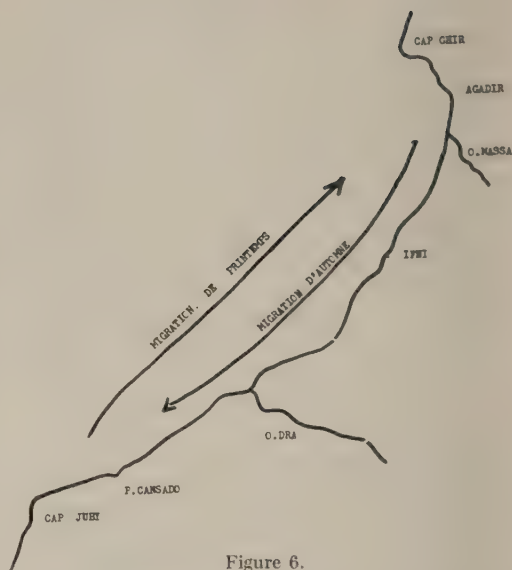


Figure 6.

Mais un prompt changement des conditions hydrologiques pouvait être attendu car les données acquises depuis 1946 nous ont appris qu'à la fin de l'hiver les eaux canariennes à 18° progressent en direction du Cap Ghir.

Il était donc possible de prévoir que ces eaux entraîneraient avec elles les sardines établies dans l'extrême sud et que la pêche serait bonne à nouveau vers le 15 Mars.

Ces prévisions se sont très exactement réalisées. A la date indiquée une poussée chaude (17.5°—18.5°) venant du sud-ouest atteignait les parages du Cap Ghir y ramenant les sardines, grandes et petites, parties trois mois plus tôt.

JEAN FURNESTIN.

## THONIDÉS

### Le Thon Rouge (*Thunnus thynnus* L.) dans le Golfe de Gascogne en 1951.

La pêche du thon rouge (*Thunnus thynnus* L.) à St-Jean-de-Luz a débuté le 13 Avril et s'est terminée le 23 Octobre 1951.

Elle a présenté les caractères indiqués dans le tableau en haut de la page suivante.

En Juin 1951, quelques *Thunnus thynnus* de 15 à 25 Kg. présentaient des gonades en période de maturité sexuelle (déjà observé en 1950).

## La pêche du Thon rouge.

|                                                 | Mois                              | Avril     | Mai     | Juin              | Juillet             | Août                  | Sept.                                       | Oct.  |
|-------------------------------------------------|-----------------------------------|-----------|---------|-------------------|---------------------|-----------------------|---------------------------------------------|-------|
| Apports (3760 tonnes ainsi réparties) . . . . . |                                   | 12        | 258     | 665               | 652                 | 838                   | 867                                         | 467   |
| Taille {                                        | Long. totale (Lt) en cm. . . . .  | 70—82     | 70—85   | 75—100<br>100—125 | > 125 <sup>1)</sup> | 125—150 <sup>1)</sup> | 125—150<br>70—82                            | 80—82 |
|                                                 | Long. caudale (Lc) en cm. . . . . | 65—78     | 65—70   | 70—92<br>95—115   | > 120               | 120—145               | 120—145<br>(mode 136)<br>68—76<br>(mode 72) | 76—78 |
| Poids moyen en Kg. (poisson éviscéré) . . . . . |                                   | 3.5 à 7.5 | 4 à 7.5 | 6 à 15<br>15 à 25 | 20 à 35             | 25 à 60               | 25 à 60<br>4 à 7                            | 6 à 8 |

<sup>1)</sup> Présence de thons rouges de 200 à 250 Kg.

Au mois de Septembre, les gros thons disparaissent et sont remplacés par des petits thons de 4 à 6 Kg.

L'apparition en Avril, puis en Septembre, de jeunes thons de 4 à 8 Kg. laisse penser à l'arrivée dans ces parages de bancs d'origines géographiques différentes.

En fin de Novembre et au début de Décembre 1951, ces jeunes thons rouges de 3 à 4 Kg. et de 7 à 10 Kg. étaient encore aperçus à 2 et 5 milles de terre, au large de Cap Breton.

Au cours de l'hiver, les thons ne s'écartent pas tous du Golfe; les pêcheurs en aperçoivent de temps à autre, sautant dans l'eau.

Observations de P. CREAC'H.

Mensurations de CASTAGNÉ et FAUVEL.

JEAN LE GALL.

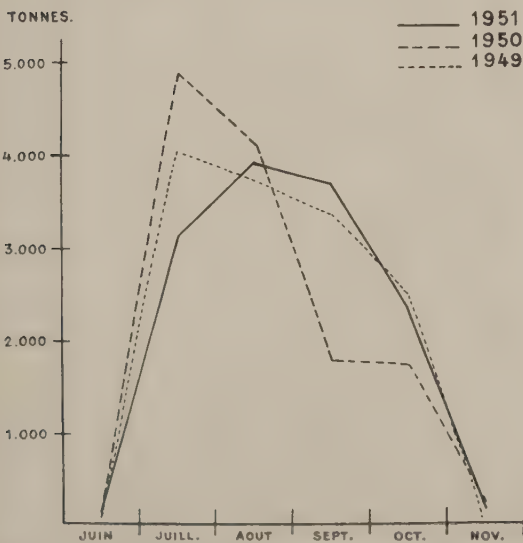


Figure 7. Apports mensuels de Germons pendant la saison de pêche (Juin-Novembre) au cours des années 1949-1950-1951.

Le Germon (*Germo alalunga* GMELIN)

dans le Golfe de Gascogne et en Mer Celtique.

## I. Statistiques.

Les quantités de germons (*Germo alalunga* Gm.) débarquées dans les ports thoniers, de Juin à Novembre, au cours de la campagne de pêche 1951, se sont élevées à 13,036 tonnes (contre 12,588 en 1950), avec la répartition mensuelle suivante:

| Mois             | Juin | Juill. | Août | Sept. | Oct. | Nov. | Total  |
|------------------|------|--------|------|-------|------|------|--------|
| Tonnes . . . . . | 9    | 3075   | 3884 | 3662  | 2331 | 75   | 13,036 |
| cf. 1950: Ton.   | 6    | 4841   | 4078 | 1783  | 1752 | 128  | 12,588 |
| cf. 1949: Ton.   | 4    | 4010   | 3775 | 3379  | 2427 | 6    | 13,601 |

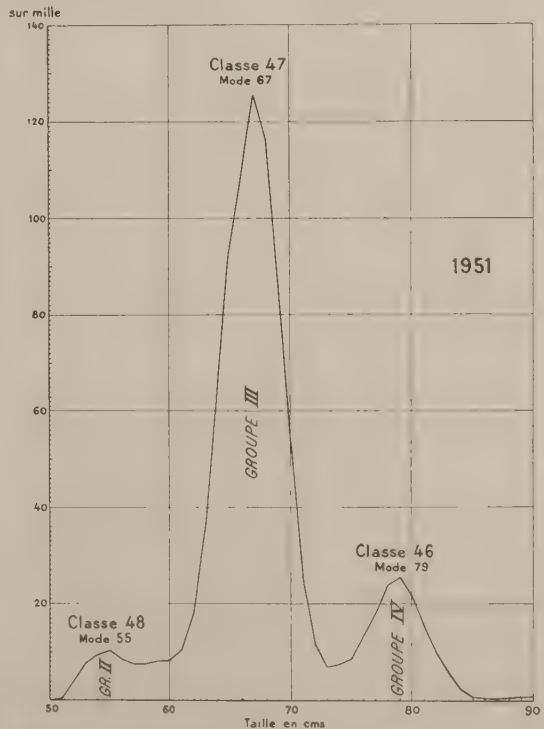


Figure 8. Répartition globale, d'après leur taille, des Germons mesurés pendant la campagne de pêche 1951.



**Tableau 20.**

| Taille 1951 — Répartition mensuelle. |       |      |       |      |         | Comparaison 1949—1950—1951. |      |      |      |                     |
|--------------------------------------|-------|------|-------|------|---------|-----------------------------|------|------|------|---------------------|
| Juin                                 | Juil. | Août | Sept. | Oct. | Moyenne | Long.<br>en cm.             | 1951 | 1950 | 1949 | Moyenne<br>générale |
| —                                    | —     | —    | —     | —    | —       | 49                          | —    | 01   | 01   | 01                  |
| —                                    | 04    | —    | —     | —    | 01      | 50                          | 01   | 01   | 03   | 02                  |
| 10                                   | 09    | —    | —     | —    | 04      | 1                           | 04   | 03   | 12   | 06                  |
| 130                                  | 33    | 12   | —     | 02   | 36      | 2                           | 36   | 18   | 41   | 35                  |
| 260                                  | 65    | 32   | 03    | 41   | 80      | 3                           | 80   | 59   | 115  | 85                  |
| 200                                  | 93    | 63   | 09    | 112  | 95      | 4                           | 95   | 119  | 214  | 143                 |
| 170                                  | 71    | 99   | 19    | 172  | 106     | 5                           | 106  | 187  | 296  | 196                 |
| 30                                   | 73    | 114  | 31    | 174  | 84      | 6                           | 84   | 248  | 325  | 219                 |
| 30                                   | 48    | 115  | 63    | 119  | 75      | 7                           | 75   | 279  | 288  | 214                 |
| 30                                   | 54    | 110  | 85    | 97   | 75      | 8                           | 75   | 288  | 218  | 194                 |
| 70                                   | 54    | 91   | 94    | 92   | 80      | 9                           | 80   | 271  | 142  | 164                 |
| 100                                  | 53    | 83   | 69    | 98   | 81      | 60                          | 81   | 238  | 86   | 135                 |
| 260                                  | 73    | 68   | 57    | 71   | 106     | 1                           | 106  | 191  | 54   | 117                 |
| 500                                  | 162   | 93   | 59    | 63   | 175     | 2                           | 175  | 151  | 34   | 120                 |
| 1000                                 | 410   | 178  | 113   | 112  | 363     | 3                           | 363  | 141  | 35   | 180                 |
| 1500                                 | 867   | 379  | 256   | 269  | 654     | 4                           | 654  | 188  | 64   | 302                 |
| 1700                                 | 1175  | 716  | 539   | 544  | 935     | 5                           | 935  | 331  | 131  | 466                 |
| 1560                                 | 1576  | 1090 | 888   | 949  | 1212    | 6                           | 1212 | 607  | 284  | 700                 |
| 1030                                 | 1372  | 1312 | 1218  | 1348 | 1256    | 7                           | 1256 | 904  | 485  | 880                 |
| 630                                  | 1000  | 1254 | 1330  | 1580 | 1159    | 8                           | 1159 | 990  | 633  | 930                 |
| 270                                  | 571   | 937  | 1122  | 1389 | 857     | 9                           | 857  | 843  | 684  | 795                 |
| 100                                  | 280   | 569  | 728   | 989  | 533     | 70                          | 533  | 568  | 574  | 558                 |
| 15                                   | 123   | 264  | 325   | 534  | 252     | 1                           | 252  | 349  | 436  | 346                 |
| 30                                   | 40    | 119  | 134   | 274  | 119     | 2                           | 119  | 193  | 280  | 197                 |
| 30                                   | 66    | 59   | 60    | 136  | 70      | 3                           | 70   | 99   | 221  | 130                 |
| 70                                   | 88    | 62   | 75    | 75   | 74      | 4                           | 74   | 46   | 129  | 83                  |
| 60                                   | 115   | 94   | 102   | 61   | 86      | 5                           | 86   | 33   | 113  | 77                  |
| 100                                  | 167   | 157  | 165   | 80   | 134     | 6                           | 134  | 44   | 149  | 109                 |
| 70                                   | 247   | 247  | 250   | 93   | 181     | 7                           | 181  | 60   | 215  | 152                 |
| 30                                   | 305   | 331  | 409   | 109  | 237     | 8                           | 237  | 85   | 319  | 214                 |
| 15                                   | 315   | 370  | 477   | 95   | 254     | 9                           | 254  | 133  | 483  | 290                 |
| —                                    | 216   | 331  | 450   | 77   | 215     | 80                          | 215  | 160  | 580  | 318                 |
| —                                    | 124   | 246  | 324   | 68   | 154     | 1                           | 154  | 273  | 605  | 344                 |
| —                                    | 68    | 158  | 195   | 58   | 95      | 2                           | 95   | 331  | 493  | 306                 |
| —                                    | 45    | 90   | 107   | 40   | 56      | 3                           | 56   | 338  | 364  | 253                 |
| —                                    | 13    | 46   | 40    | 22   | 24      | 4                           | 24   | 299  | 263  | 195                 |
| —                                    | 01    | 19   | 19    | 12   | 10      | 5                           | 10   | 218  | 151  | 123                 |
| —                                    | —     | 08   | 14    | 07   | 06      | 6                           | 06   | 173  | 95   | 91                  |
| —                                    | —     | 09   | 17    | 05   | 06      | 7                           | 06   | 113  | 43   | 54                  |
| —                                    | —     | 11   | 23    | 05   | 08      | 8                           | 08   | 68   | 28   | 35                  |
| —                                    | 01    | 14   | 26    | 05   | 09      | 9                           | 09   | 44   | 27   | 27                  |
| —                                    | —     | 14   | 26    | 04   | 09      | 90                          | 09   | 37   | 29   | 25                  |
| —                                    | 01    | 11   | 19    | —    | 06      | 1                           | 06   | 40   | 37   | 28                  |
| —                                    | —     | 08   | 15    | 02   | 05      | 2                           | 05   | 31   | 39   | 25                  |
| —                                    | 05    | 04   | 09    | 04   | 04      | 3                           | 04   | 39   | 40   | 28                  |
| —                                    | —     | 03   | 08    | 04   | 03      | 4                           | 03   | 33   | 38   | 25                  |
| —                                    | —     | 02   | 05    | 02   | 02      | 5                           | 02   | 23   | 29   | 18                  |
| —                                    | —     | 01   | 03    | —    | 01      | 6                           | 01   | 18   | 23   | 14                  |
| —                                    | —     | 01   | 01    | —    | —       | 7                           | —    | 10   | 16   | 09                  |
| —                                    | —     | 01   | 03    | —    | 01      | 8                           | 01   | 08   | 11   | 07                  |
| —                                    | —     | 01   | 01    | 02   | 01      | 9                           | 01   | 06   | 09   | 05                  |
| —                                    | —     | 01   | 01    | 05   | 01      | 100                         | 01   | 04   | 07   | 04                  |
| —                                    | —     | 01   | —     | 05   | 01      | 1                           | 01   | 00   | 08   | 03                  |
| —                                    | —     | 01   | —     | 04   | 01      | 2                           | 01   | 02   | 05   | 03                  |
| —                                    | —     | 01   | —     | —    | —       | 3                           | —    | 02   | 05   | 02                  |
| —                                    | —     | 01   | —     | —    | —       | 4                           | —    | 03   | 03   | 02                  |
| —                                    | —     | 01   | —     | —    | —       | 5                           | —    | 01   | 02   | 01                  |
| —                                    | —     | —    | —     | —    | —       | 6                           | —    | 01   | 01   | 05                  |

Moyenne générale 1949—1951: Modes

56: Groupe II : de 50 à 62 cm.  
 68: Groupe III: de 59 à 77 cm.  
 81: Groupe IV: de 72 à 90 cm.  
 93: Groupe V : de 86 à 100 cm.

Les modes sont en caractères gras.

Les mensurations de germons faites sur les lieux de pêche et dans les ports de débarquement au cours de cette campagne de pêche ont porté sur 19,854 germons.

*Taille* — Leur répartition mensuelle, quant à leur longueur totale (mesurée du bout du museau au milieu de la ligne joignant les extrémités de la nageoire caudale), est exposée dans le Tableau 20, qui donne également la répartition moyenne pour toute la campagne 1951.

Dans le même tableau, sont comparés les résultats moyens obtenus au cours des trois dernières campagnes (1949-1950-1951). La moyenne générale, donnant, d'après la taille, la répartition moyenne des germons, en période de dispersion trophique, dans le Golfe de Gascogne et aux accores de la Mer Celtique, est établie sur plus de 50,000 individus mesurés au cours de ces trois dernières années.

## II. Considérations sur les résultats.

### 1. Corrélation: Longueur totale (Lt)/Longueur milieu caudale.

La longueur totale (Lt) est la longueur mesurée «hors tout», c'est-à-dire: du bout du museau au milieu de la ligne joignant les pointes de la nageoire caudale.

La technique américaine définit comme Longueur totale: la longueur mesurée du bout du museau au milieu de la fourche caudale (= Lc).

Ces deux mensurations ont été faites à titre comparatif pour l'établissement d'un facteur de conversion permettant de comparer les résultats obtenus par l'une ou par l'autre des deux méthodes.

$$Lt = k.Lc$$

Nous avons fixé (LE GALL, Ann. Biol. 1949, p. 74) la valeur moyenne de  $k$  à 1.0771.

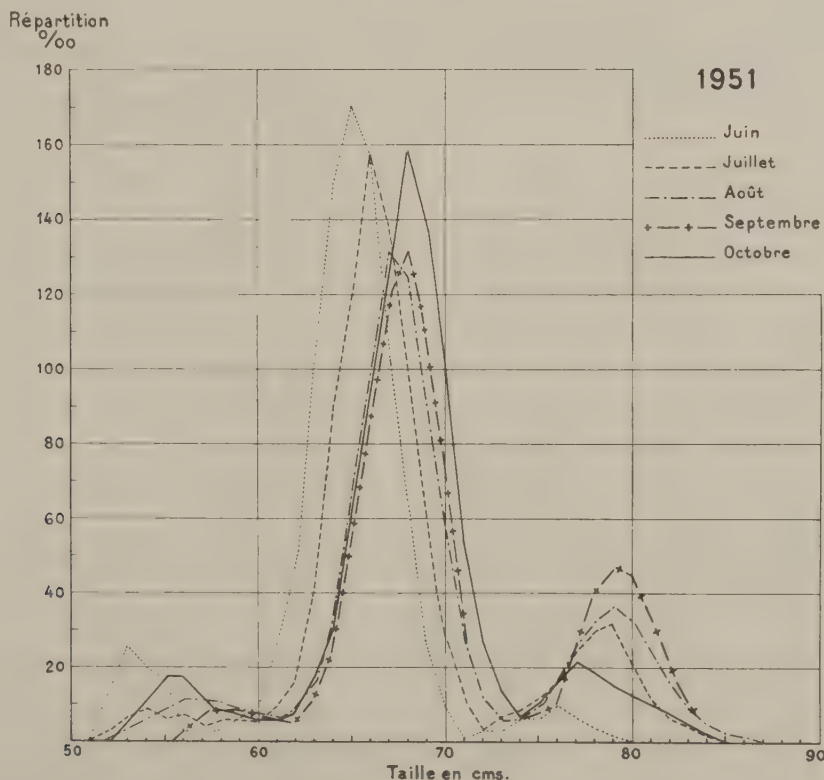


Figure 9. Répartition mensuelle, d'après leur taille, des Germons étudiés.

De nouvelles observations ont montré que  $k$  varie :

- a) et croît avec la taille du poisson;
- b) avec son état de fraîcheur (différences dans les observations faites à bord ou au débarquement);
- c) le mode de conservation à bord.

Nous estimons que la valeur de  $k$  peut être portée au chiffre voisin arrondi de 1.08 sans nuire à la précision désirable dans l'interprétation des résultats.

## 2. Répartition générale d'après la taille.

Le graphique 7 montre la répartition moyenne, d'après leur taille, des germons capturés de 1949 à 1951.

Dans son allure générale, ce graphique est absolument identique à ceux précédemment établis d'après les mensurations de LETACONNOUX-FOREST-ANCELLIN (1947 et 1948) et de PRIOL (1935—1938) (Ann. Biol., *loc. cit.*).

Trois classes annuelles, appelées «Groupes», y apparaissent, nettement représentées par les courbes «en cloches» classiques, suivies d'une quatrième classe bien moins nette.

Ce sont les groupes suivants :

### Groupe II —

Germons de 2 ans révolus;  
Taille modale : 56 cm.  
Longueur : de 50 à 62 cm.  
Longueur moyenne : 57 cm.

### Groupe III —

Germons de 3 ans révolus.  
Taille modale : 68 cm.  
Longueur : de 60 à 77 cm.  
Longueur moyenne : 68.50 cm.

### Groupe IV —

Germons de 4 ans révolus.  
Taille modale : 81 cm.  
Longueur : de 73 à 92 cm.  
Longueur moyenne : 81.60 cm.

La quatrième classe, moins nette, parce que mal représentée sur les pêcheries de l'Atlantique Nord-Est, est constituée par des germons du groupe V, âgés de 5 ans révolus; taille modale : 93 cm. longueur de 86 à 100 cm. taille moyenne imprécisée.

Quelques germons plus âgés apparaissent également dans le Golfe et en bordure du Plateau Continental Celte. Ils sont rares.

## 3. Importance relative de chaque groupe.

D'après ces résultats, l'importance relative de chacun de ces groupes a été calculée, pour l'ensemble des observations d'abord (Moyenne des années 1949-1950-1951), puis, pour chaque année.

|                    | Groupe II | Groupe III | Groupe IV | Groupe V et plus âgés |
|--------------------|-----------|------------|-----------|-----------------------|
| Moyenne Générale % | 14.2      | 57.7       | 25.6      | 2.5                   |
| 1951               | 7.8       | 75.7       | 15.0      | 1.6                   |
| 1950               | 20.5      | 53.5       | 24.0      | 2.8                   |
| 1949               | 14.4      | 44.1       | 38.5      | 3.0                   |

Ce qui montre que, en général, les apports de germons capturés sur les pêcheries du Golfe de Gascogne et de la Mer Celtique sont constitués en majeure partie (environ 80 %) par des poissons des groupes III et IV (de 60 à 90 cm. de long.)<sup>1)</sup> particulièrement du groupe

<sup>1)</sup> Les poissons des groupes III et IV constituent en moyenne, 82,6 % du stock de germons présents sur ces pêcheries.

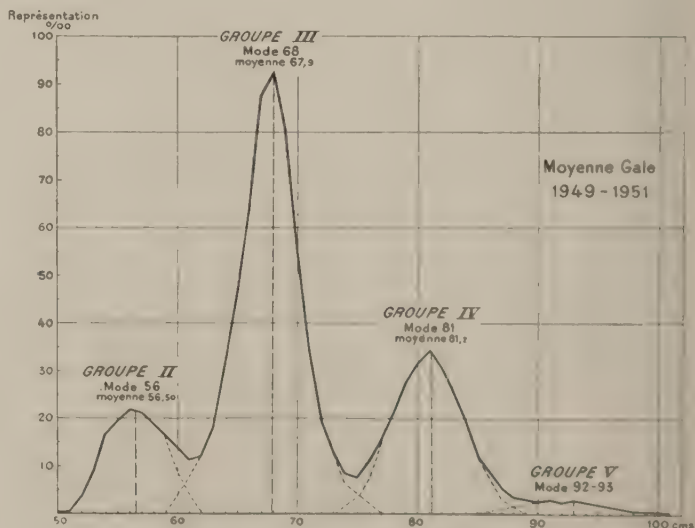


Figure 10. Répartition globale d'après leur taille des Germons mesurés en 1949-1950-1951. (Moyenne Générale. N = 50,864).



III qui constitue, en moyenne, un peu plus de la moitié de stock (57.7 %).

Le groupe II, dont c'est la première apparition dans le Golfe, constitue un complément dont l'importance est variable suivant les années (8 à 20 %).

Le groupe V, et les germons plus âgés, restent rares dans la région prospectée, tandis qu'ils sont relativement plus nombreux dans la région de Madère et Açores et, parfois aussi, dans le fond du Golfe de Gascogne.

On remarquera encore que les germons du groupe II avec une représentation voisine de la moyenne (14.4) en 1949, se sont retrouvés en 1950, dans le groupe III avec une représentation encore voisine de la moyenne (53.5 %); et que ceux du même groupe II, fortement représentés en 1950 (20.5 %) ont reparu en 1951 dans le groupe III, dont la représentation fut nettement supérieure à la moyenne (75 %).

Bien que ces conclusions puissent paraître prématurées et demandent confirmation, l'intérêt des nombreuses mensurations faites au cours de ces campagnes de pêche apparaît évident.

Les résultats des observations faites au cours de ces dernières années ont montré que ces différents groupes annuels n'arrivent pas ensemble sur les pêcheries du Golfe et de la Mer Celtique.

Les jeunes germons du groupe II, présents dès Juin dans les rassemblements y apparaissent relativement de plus en plus nombreux dès le début de Septembre. Leur nombre augmente jusqu'à la fin d'Octobre.

Ceux du groupe III, bien représentés dès le début de Juin, dominent encore en Juillet et Août, mais diminuent ensuite.

Les germons du groupe IV et ceux encore plus âgés, faiblement représentés au début de saison, apparaissent de plus en plus nombreux jusqu'à la fin de Septembre; ils disparaissent progressivement ensuite.

Les mêmes constatations ont été faites en 1951. Leur confirmation au cours des prochaines saisons de pêche apportera, avec des précisions nécessaires sur la constitution du stock de germons, la possibilité d'établir des prévisions sur l'importance et les fluctuations de la saison de pêche qu'il est encore prématuré d'avancer.

#### 4. Corrélation taille-poids.

Pour deux individus de même taille, le poids total du corps, viscères compris, varie surtout suivant l'état de plénitude de l'estomac et les résultats obtenus sont difficilement interprétables avec précision. Pour éliminer cette cause d'erreur, il conviendrait de décider que le Poids total du poisson soit le poids du poisson saigné et éviscéré, les viscères isolés pouvant être pesés séparément: (Gonades, foie, par exemple).

$$\text{La valeur coefficient } k = \frac{100 P}{L^3}$$

où P = le poids en grammes  
et L = longueur totale en cm.

établie sur des germons non vidés, pesés à la sortie de l'eau, varie de 1.66 à 1.82. Valeur moyenne 1.74.

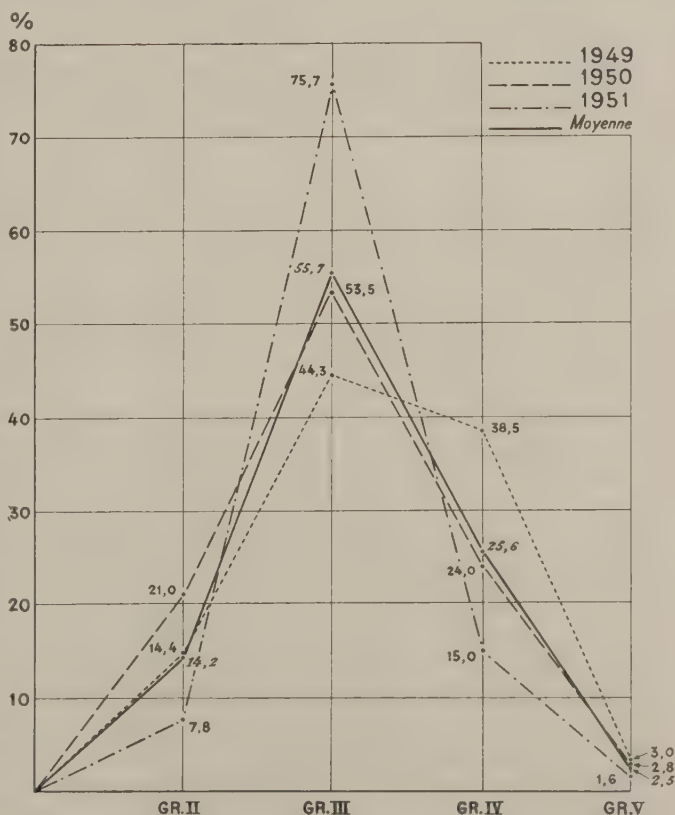


Figure 11. Répartition proportionnelle des Germons des Groupes II, III, IV et V. Moyenne Générale 1949-1951.

### 5. Corrélation poids-foie/poids total.

Le foie du germon est relativement petit et son poids, très variable, ne représente que 2.2 à 5.5 % du poids total du corps. L'étude comparative du rapport  $F = 100 \frac{\text{Poids foie}}{\text{Poids total}}$  montre que la valeur de F diminue à mesure qu'augmente le poids et, corrélativement, la taille du poisson.

Les résultats obtenus rassemblés par groupes de germons, classés suivant leur âge: Gr. II: de 2 Kg. à 3.5 Kg. — Gr. III: de 3.5 Kg. à 7 Kg. — Gr. IV: poids supérieur à 7 Kg. montrent que  $F = \frac{100 \text{ Foie}}{\text{Poids tot.}}$  est de 4.43 pour le groupe II, tombe à 3.35 pour le groupe III et à 2.57 pour le groupe IV. Elle est inférieure à 2.50 pour les germons plus âgés. Cette constatation trouve son explication dans l'état physiologique du poisson. Les germons des groupes II et III sont des immatures; ceux du groupe IV ont vraisemblablement pondu une première fois. Les uns et les autres sont en période de dispersion trophique.

JEAN LE GALL.

## POISSONS DIVERS

### Note sur deux Dentés

(*Dentex maroccanus* VAL. et  
*Dentex macrophthalmus* BLOCH)  
du Maroc.

*Dentex maroccanus* (VAL.) et *Dentex macrophthalmus* (BLOCH) sont des espèces très voisines par les proportions du corps, la denture, la disposition des nageoires, le nombre des rayons, la coloration, ce qui rend leur détermination parfois difficile quand on les observe séparément.

Nous avons entrepris l'étude biométrique détaillée de ces deux espèces pour mettre en évidence ce qui dans leur morphologie peut permettre de les distinguer l'une de l'autre sans confusion possible.

1) **Caractères métriques** — A cette fin nous avons étudié sous forme d'indices (longueur du caractère multipliée par 100 et divisée par la longueur totale) les proportions du corps, au nombre de 19 d'après 113 *D. maroccanus* et 102 *D. macrophthalmus*, dont la taille s'éche-

lonnait entre 11 et 30 cm. pour les premiers, entre 14 et 33 cm. pour les seconds.

Aucun des indices calculés ne varie avec la taille (donc l'âge) ni avec le sexe, en dehors des limites des erreurs permises. Nous avons donc pu calculer pour l'une et l'autre espèce la valeur moyenne de chaque caractère (Tableau 21).

Si certains de ces caractères ne présentent pas de différence, d'autres permettent de bien séparer les deux espèces considérées. Ce sont:

| Caractère                                                                        | <i>D. maroc-</i><br><i>canus</i> | <i>D. macroph-</i><br><i>thalmus</i> |
|----------------------------------------------------------------------------------|----------------------------------|--------------------------------------|
| Distance préorbitaire contenue dans l'orbite.....                                | 0.9 fois                         | 1.2 fois                             |
| Espace interorbitaire contenu dans la distance préorbitaire...                   | 1.4 -                            | 1.0 -                                |
| Espace sous-orbitaire contenu dans la tête.....                                  | 5.5 -                            | 9.3 -                                |
| Longueur du maxillaire contenue dans la longueur de la mâchoire inférieure ..... | 1.0 -                            | 1.2 -                                |

2) **Caractères numériques.** — Le nombre des vertèbres est constant et égal à 23 chez l'une et l'autre des deux espèces. Il en est de même pour les rayons de la nageoire ventrale (I+5). Le nombre des rayons de la dorsale (XII—10+I) et celui des rayons de l'anale (III—8+I) sont pratiquement les mêmes chez *D. maroccanus* et *D. macrophthalmus*.

En revanche la différence dans le nombre des rayons de la pectorale quoique faible (d'une unité seulement) est constante (moyenne: *D. maroccanus*; 15— *D. macrophthalmus*; 16.07).

De même les écailles de la ligne latérale pour 113 *D. maroccanus* et 102 *D. macrophthalmus* sont au nombre de 48 à 50 chez le premier et de 54 à 56 chez le second.

Enfin le nombre des branchiospines varie de 17 à 21 chez *D. maroccanus* de 27 à 31 chez *D. macrophthalmus*.

3) **Différences physiologiques.** De l'examen des glandes sexuelles de l'un et l'autre de ces deux Spares il ressort que *D. macrophthalmus* se reproduit en Mars-Avril et *D. maroccanus* en Mai-Juin.

A noter une différence sexuelle marquée dans la coloration de *D. maroccanus* au moment de la reproduction. Tandis que la teinte générale de la femelle est rose-carmin pâle avec des nageoires pectorales, ventrales et anale blanchâtres, les mâles se parent d'une teinte rouge-corail très vive soulignant le bord supérieur du corps, le profil supérieur de la tête,

**Tableau 21. Tableau comparatif des moyennes d'indices biométriques pour *Dentex maroccanus* et *Dentex macrophthalmus*.**

| Indice ou valeur du caractère multiplié par 100 et divisé par la longueur totale | <i>Dentex maroccanus</i> |                 |      | <i>Dentex macrophthalmus</i> |                 |      |
|----------------------------------------------------------------------------------|--------------------------|-----------------|------|------------------------------|-----------------|------|
|                                                                                  | Valeur Ind. de moy.      | Ind. de variab. | Fl m | Valeur Ind. de moy.          | Ind. de variab. | Fl m |
| Haut. du corps....                                                               | 31.19                    | 1.38            | 0.43 | 30.54                        | 1.40            | 0.47 |
| Long. de la tête...                                                              | 26.80                    | 0.74            | 0.23 | 28.02                        | 0.64            | 0.20 |
| Dist. postorbit....                                                              | 17.64                    | 0.73            | 0.23 | 17.99                        | 0.56            | 0.19 |
| Dist. préorbit....                                                               | 9.00                     | 0.68            | 0.21 | 8.15                         | 0.54            | 0.18 |
| Diam. de l'orbite...                                                             | 8.70                     | 0.68            | 0.21 | 9.87                         | 0.81            | 0.27 |
| Dist. interorbit....                                                             | 6.41                     | 0.49            | 0.15 | 7.63                         | 0.59            | 0.19 |
| Esp. sous-orbit....                                                              | 4.84                     | 0.51            | 0.16 | 3.30                         | 0.47            | 0.16 |
| Long. maxill....                                                                 | 10.68                    | 0.65            | 0.21 | 11.47                        | 0.50            | 0.16 |
| Long. mandib....                                                                 | 11.07                    | 0.40            | 0.13 | 13.54                        | 0.73            | 0.24 |
| Dist. prédors....                                                                | 32.64                    | 1.07            | 0.34 | 31.44                        | 1.10            | 0.37 |
| Dist. préventr....                                                               | 30.27                    | 0.98            | 0.31 | 31.76                        | 0.92            | 0.30 |
| Dist. préanale....                                                               | 48.31                    | 1.32            | 0.42 | 49.81                        | 1.30            | 0.43 |
| Esp. ventr.-an....                                                               | 23.46                    | 1.40            | 0.44 | 23.02                        | 1.33            | 0.44 |
| Long. base dors....                                                              | 40.37                    | 1.00            | 0.31 | 40.20                        | 1.14            | 0.38 |
| Long. base an....                                                                | 14.57                    | 0.73            | 0.23 | 14.10                        | 0.79            | 0.26 |
| Long. pector....                                                                 | 26.72                    | 1.16            | 0.37 | 26.94                        | 0.99            | 0.33 |
| Long. ventrale....                                                               | 18.65                    | 0.82            | 0.25 | 18.57                        | 0.81            | 0.27 |
| Haut. dorsale....                                                                | 13.03                    | 0.74            | 0.24 | 12.31                        | 0.81            | 0.25 |
| Haut. ped. caud....                                                              | 9.12                     | 0.44            | 0.14 | 8.60                         | 0.51            | 0.17 |

le museau, les mâchoires et les nageoires. On peut ainsi séparer les sexes à première vue et sans confusion possible. Cette différence sexuelle n'existe pas chez *D. macrophthalmus*.

RENÉ COUPÉ.

### *Mugil chelo* CUVIER.

#### Note sur les Muges des Côtes Marocaines.

A ce jour, nous avons rencontré au Maroc les espèces de Muges ci-dessous :

1) *Mugil cephalus* L. ayant, comme celui des côtes de Mauritanie et du Sénégal, la partie inférieure des pelviennes, anale et caudale, jaune canari. On le pêche aussi bien sur le littoral (lagunes, embouchures des oueds, eaux marines) où les immatures semblent séjourner toute l'année, qu'assez loin en rivière. Il atteint la taille de 80 cm. et le poids de 2,500 g. à 3 kg. Les adultes font l'objet d'une pêche active d'Avril à Août.

2) *Mugil auratus* Risso, qui n'atteint pas la taille du *Mugil cephalus* L., peut dépasser 50 cm.

3) *Mugil saliens* Risso, comme l'espèce précédente, fréquente les lagunes et embouchures des oueds.

4) *Mugil capito* C. V. Le plus euryhalin de tous, il remonte en rivière jusqu'à 200—300

km. à l'intérieur des terres, et entreprend sa migration génétique vers la mer au mois d'Avril.

5) *Mugil chelo* CUVIER, comme *Mugil cephalus* L. atteint la taille de 80 cm. et le poids de 3 kg. On le pêche dans les lagunes, les embouchures des oueds, les eaux marines littorales jusqu'à 2 milles de la côte.

6) En plus de ces cinq espèces, il en existe une sans paupière adipeuse, à isthme jugulaire ovale, à corps étiré et à pectorales falciformes jaunâtres dont la longueur égale celle de la tête qui est comprise 5 fois 1/2 dans la longueur totale. Elle reste cantonnée dans les embouchures des oueds. Faute de documentation suffisante, nous n'avons encore pu la déterminer.

Pour chacune de ces espèces, une étude a été entreprise qui intéresse les caractères morphologiques, la croissance établie par la méthode scalimétrique, l'évolution des glandes sexuelles.

Sont rapportés ici les premiers résultats obtenus sur l'âge et la croissance de l'une d'elles: *Mugil chelo* CUVIER = (*Mugil labrosus* Risso = *Mugil provensalis* Risso).

#### A. Age et croissance.

L'examen des écailles (prélevées à hauteur et en arrière des pectorales) de 21 *Mugil chelo* CUVIER de 17 à 79 cm., nous a fourni les résultats consignés dans le tableau ci-dessous :

| Taille en cm. | Taille calculée en mm. |     |     |     |     |     |     |     |     |     |
|---------------|------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|               | L1                     | L2  | L3  | L4  | L5  | L6  | L7  | L8  | L9  | L10 |
| 17            | 120                    | —   | —   | —   | —   | —   | —   | —   | —   | —   |
| 19            | 134                    | 190 | —   | —   | —   | —   | —   | —   | —   | —   |
| 19            | 149                    | 184 | —   | —   | —   | —   | —   | —   | —   | —   |
| 21            | 42                     | 133 | —   | —   | —   | —   | —   | —   | —   | —   |
| 24            | 135                    | 210 | —   | —   | —   | —   | —   | —   | —   | —   |
| 26            | 54                     | 127 | 206 | —   | —   | —   | —   | —   | —   | —   |
| 30            | 107                    | 188 | 263 | —   | —   | —   | —   | —   | —   | —   |
| 30            | 93                     | 182 | 247 | 282 | —   | —   | —   | —   | —   | —   |
| 31            | 45                     | 158 | 243 | 294 | —   | —   | —   | —   | —   | —   |
| 32            | 89                     | 158 | 242 | 320 | —   | —   | —   | —   | —   | —   |
| 33            | 70                     | 135 | 222 | 314 | —   | —   | —   | —   | —   | —   |
| 34            | 140                    | 235 | 300 | —   | —   | —   | —   | —   | —   | —   |
| 34            | 94                     | 164 | 258 | 328 | —   | —   | —   | —   | —   | —   |
| 37            | 100                    | 188 | 276 | 357 | —   | —   | —   | —   | —   | —   |
| 38            | 57                     | 141 | 193 | 245 | 318 | —   | —   | —   | —   | —   |
| 44            | 107                    | 214 | 339 | 409 | —   | —   | —   | —   | —   | —   |
| 46            | 82                     | 142 | 224 | 301 | 384 | —   | —   | —   | —   | —   |
| 55            | 133                    | 266 | 387 | 447 | 489 | 538 | —   | —   | —   | —   |
| 59            | 133                    | 191 | 254 | 335 | 399 | 486 | 572 | —   | —   | —   |
| 70            | 84                     | 188 | 227 | 272 | 324 | 376 | 447 | 518 | 583 | 642 |
| 79            | 81                     | 192 | 280 | 346 | 405 | 494 | 538 | 582 | 649 | 700 |

L11, 730; — L12, 752; — L13, 774.

Le nombre d'anneaux d'hiver correspond au nombre des L. calculés.



Une cause d'erreur, signalée par PAGET dans son étude de la croissance des Muges d'Egypte, est due au fait que le premier anneau d'hiver n'est pas toujours net. Ce que l'on prend parfois pour le premier anneau est en réalité le second.

Compte tenu de cette remarque, les résultats du tableau ci-dessus, établis d'après la méthode scalimétrique habituelle, donnent avec une approximation suffisante la vitesse de croissance de l'espèce.

Il semble que *Mugil chelo* CUVIER ne puisse guère dépasser 80 cm., taille à laquelle il aura de 12 à 14 ans.

#### B. Evolution des glandes sexuelles.

L'examen des gonades de cinquante individus de 13 à 50 cm. permet d'affirmer que *Mugil chelo* CUVIER reste immature jusqu'au 3ème hiver.

MARTIAL ROSSIGNOL.

### Trachurus.

#### Etat Sexuel et Croissance du Saurel des Côtes Atlantiques du Maroc. (*Trachurus trachurus* L.)

##### 1) L'état sexuel.

Les observations ont été faites sur 600 individus pêchés dans le secteur de Casablanca en Janvier, Février, Mars et Avril 1951 et 1952.

a) Pour tous les saurels de 16—17 cm. à 43 cm. la pleine maturité sexuelle est atteinte au début du printemps (Mars-Avril). Les individus de taille inférieure à 14 cm. sont immatures.

b) La corrélation taille-poids établie pour 285 mâles et 243 femelles ne montre aucune différence entre les deux sexes.

c) Il ne semble pas y avoir anorexie chez le saurel en voie de reproduction (sur 50 individus examinés 25 seulement avaient l'estomac vide).

##### 2) La croissance.

a) Variations des proportions relatives du corps avec la taille:

Ces proportions ont été calculées, soit en % de la longueur latérale de la tête, soit en % de la longueur du corps, à partir de distances mesurées au compas sur 47 individus de toutes les tailles entre 8 et 43 cm.

En fonction de la croissance linéaire:

— la longueur relative de la tête diminue,

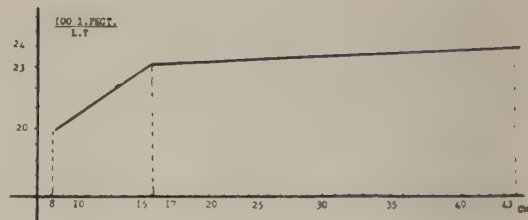


Figure 12. Variations de  $\frac{100 \text{ l. Pect.}}{\text{L.T.}}$

- la région post-orbitaire s'allonge plus rapidement que la partie antérieure de la tête,
  - la croissance de la pectorale (pour 120 individus), plus rapide chez les jeunes (jusqu'à 16—17 cm.) que chez les adultes, semble en rapport avec l'évolution sexuelle (Fig. 12).
  - les diverses autres proportions du corps ne paraissent pas varier avec la taille.
- b) Corrélation taille-poids.

Etablie pour 820 individus (560 matures de 16 à 43 cm. en Avril 1951 et 260 immatures de 11 à 16 cm. en Mars 1952) elle est représentée par une courbe figurant deux tronçons de parabole (Fig. 13), à l'intersection desquels

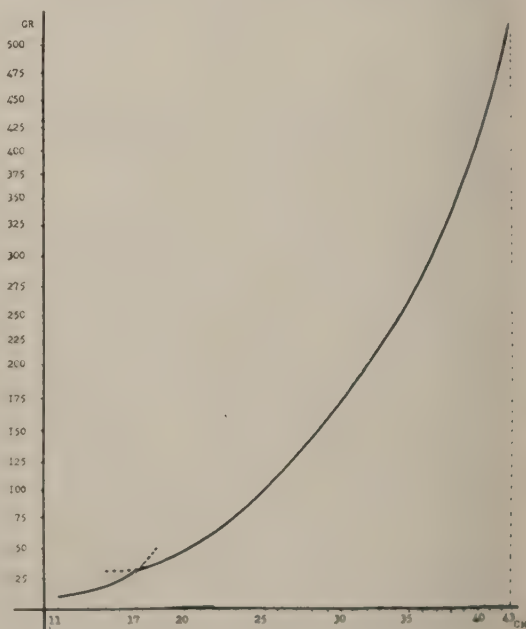


Figure 13. Corrélation Taille-Poids.

semble se situer le stade critique de la puberté. Pendant la phase juvénile, jusqu'à 16—17 cm., la croissance pondérale est plus rapide que pendant la phase adulte; cette observation rejoint celle qui a été faite à propos de la pectorale.

Un travail ultérieur portant sur un plus grand nombre d'individus nous permettra de mieux préciser ces variations dans la croissance du saurel.

RENÉ GAIL.

#### Notule sur *Trachurus picturatus* BOWDICH.

Au cours de mon étude sur le *Trachurus trachurus* L. j'ai recherché l'espèce voisine *Trachurus picturatus* BOWDICH.

J'ai constaté qu'elle est aussi rare que l'autre est abondante.

Pendant les mois de Mars, Avril, Mai et Juin 1951, puis de Janvier, Février et Mars 1952 malgré des recherches presque quotidiennes je n'ai récolté que quatre spécimens de 25, 29, 30 et 41 cm. de longueur totale (deux provenaient d'une pêche côtière, les deux autres étaient parmi des lots de *T. trachurus* capturés au chalut).

On pouvait espérer que cette espèce, qui paraît être absente des mers européennes et qui est rare sur la côte ibérique serait abondante en Afrique du Nord. Or il n'en n'est rien, *T. picturatus* ne vit pas au Maroc en bancs nombreux comme l'espèce voisine mais se trouve plus ou moins épars dans les groupements de cette dernière.

RENÉ GAIL.

## CRUSTACÉS

### Note préliminaire sur les Crevettes des Côtes du Maroc.

L'exportation des crevettes, congelées ou en conserve, a augmenté sensiblement l'importance économique de ces Crustacés au Maroc.

Les espèces pêchées au chalut fréquentent le Plateau Continental et le talus de ce Plateau. Elles appartiennent aux deux seules familles qui ont une importance économique: les Pénéidés et les Pandalidés. D'autres genres et espèces se trouvent sur le littoral, mais ne font l'objet que de cueillette locale, nous ne les citerons pas ici.

#### A) — Famille des Pénéidés.

Les espèces importantes pour la pêche appartenant à cette famille sont les suivantes:

1) *Parapenaeus longirostris* LUCAS, cité parfois sous le nom de *Parapenaeus membranaceus* Risso est, de très loin, la plus abondante. Elle est généralement appelée «crevette rose du large»; on la capture sur les fonds vaseux ou sablo-vaseux de 50 à 400 m. Sa pêche se fait donc de part et d'autre de la barrière de coraux (*Dendrophyllies*) qui, devant Casa-blanca, se situe entre 110 et 180 m. environ.

2) *Penaeopsis serratus* BATE; cette crevette très souvent pêchée avec la précédente se tient principalement au large de la barrière de

*Dendrophyllies*: à partir de 200 m. environ de profondeur.

Ainsi qu'on peut l'observer chez la plupart des Pénéidés, les mâles de *Penaeopsis serratus* sont sensiblement plus petits que les femelles:

Pour 158 mâles et 169 femelles mesurés, nous avons obtenu les tailles suivantes:

|               | Taille, cm. |    |    |    |    |    | Taille    |
|---------------|-------------|----|----|----|----|----|-----------|
|               | 10          | 11 | 12 | 13 | 14 | 15 | moyenne   |
| Mâles . . . . | 26          | 99 | 33 | —  | —  | —  | 11.04 cm. |
| Femelles . .  | —           | 4  | 51 | 93 | 20 | 1  | 12.79 -   |

Une autre différence sexuelle importante nous est apparue chez 327 spécimens de cette espèce: le mâle présente un fouet antennulaire interne fortement courbé en baïonnette, alors qu'il est toujours droit chez la femelle.

3) *Aristeomorpha foliacea* Risso, appelée par nos pêcheurs: «grande crevette rouge», se pêche à plus de 250 m. de profondeur principalement sur fonds vaseux. Sa taille peut atteindre 25 cm. Cette crevette est très recherchée et pourrait avoir une importance économique appréciable si les moyens de capture étaient mieux adaptés aux grands fonds.

4) *Aristeus antennatus* Risso; parfois capturé avec *A. foliacea*, ce Crustacé est moins abondant. On le rencontre sur le talus du Plateau à partir de 300 m. Sa chair, plus fine que celle de *A. foliacea*, est très estimée.

5) *Plesiopenaeus edwardsianus* J. Y. JOHNSON; ce Pénéidé de grande taille (la femelle peut dépasser 30 cm.), n'est pris qu'accidentellement sur nos côtes; on ne le rencontre, en effet, qu'à partir de 500 m. et peu de bateaux peuvent chaluter à une telle profondeur.

Cette crevette est très recherchée et l'on peut espérer que des moyens plus puissants permettront d'en augmenter la production.

6) *Penaeus caramote* Risso, peu abondant sur les côtes du Maroc est cependant intéressant par sa taille et sa qualité. On le prend par faibles fonds (5 à 50 m.) à l'embouchure des fleuves (Oued Sebou en particulier).

7) *Solenocera membranacea* EDWARDS; cette espèce, abondante entre 15 et 150 m. sur fond de sable ou vase, se trouve mélangée dans les cargaisons avec *P. longirostris*.

B) — Famille des Pandalidés.

Une seule espèce, de cette famille, a une certaine importance économique.

*Plesionika edwardsii* (BRANDT) = *Pandalus narval* — H. M. EDWARDS; ce Pandalidé peut dépasser 15 cm.; il est assez abondant par des fonds de 200 à 400 m. Sa chair, très délicate, le fait rechercher. Les pêcheurs le nomment à tort: «Bouquet du large».

CL. MAURIN.



# North Sea.

## INTRODUCTION

In accordance with the decision of the Council at its meeting in Amsterdam, the two Sub-Committees for the Northern North Sea and the Southern North Sea have been united to form the new North Sea Sub-Committee, so that it is now possible for Reports and Annales to be prepared for the whole area. This not only has many obvious practical advantages, but should prove to be of great assistance in the very valuable co-operation now developing between various countries for the investigation of essentially international problems.

Contributions have been received from:—

|                  |          |
|------------------|----------|
| A. J. C. JENSEN, | Denmark  |
| Å. V. TÅNING     | "        |
| H. THOMSEN       | "        |
| J. A. GULLAND    | England  |
| P. DESBROSSES,   | France   |
| A. REVHEIM,      | Norway   |
| R. E. CRAIG,     | Scotland |
| R. W. ELLIS,     | "        |
| J. H. FRASER,    | "        |
| R. JONES,        | "        |
| J. LAMONT,       | "        |
| W. MAIN,         | "        |
| B. B. RAE,       | "        |
| K. M. RAE,       | "        |
| J. B. TAIT,      | "        |
| E. WILSON,       | "        |

### A. Environment.

Drift-bottle liberations between Faroe and Shetland and within the North Sea itself pointed to the general sluggishness of the surface drift during 1951, whilst the calculated intensity of the Atlantic Drift across the Wyville-Thomson Ridge in May was of the same low order as that in May 1950. Tempera-

ture—salinity values appear to have been only average. Accordingly, it is not surprising that plankton observations revealed *Sagitta setosa* as being distributed widely along with *S. elegans* in the Northern North Sea, reaching as far as 60°N., so that the planktonic conditions in that area in 1951 generally resembled those of 1950 rather than those of 1949.

### B. Fish.

**Mackerel:** Preliminary Norwegian tagging experiments are already providing useful information about the migration of the mackerel, particularly over the waters between Bergen and the Skagerak. It is striking that a large proportion of the fish were caught within a short time of tagging.

**Haddock:** Detailed analyses show that the 1945 brood was still fairly well represented in the fishery during 1951 and, along with the 1947, 1948 and 1949 broods, contributed the greater weight of haddock landed by British steam trawlers from the North Sea. There was an increase in the total weight of haddock landed by these trawlers, compared with 1950, although this increase was confined to the area north of latitude 57°30'. Once again, there was little change in the overall catch per 100 hours fishing.

**Whiting:** Tables are presented, as in 1950, as a summary of the British steam trawler landings during 1951. These data will be reviewed from time to time as they accumulate.

French investigations suggest that the age at first maturity of the whiting in the English Channel is between 2 and 3 years, i.e., rather later than off the French coast in the Atlantic.

**Plaice:** The catches of plaice by British steam trawlers in 1950 and 1951 are summarised and, in comparison with similar data already published by the Council for earlier years, they suggest that the decline from the immediately post-war high densities is nearly ceasing, so that the stock may be reaching an almost steady state.

Danish investigations show that the 0-group plaice in the Danish Waddensea were very scarce in 1951 in comparison with the relative abundance during the previous years, since 1935. The I- and II-groups were comparatively well represented early in the year although they were scarcer in the autumn.

The recaptures of Danish tagged plaice over the Dogger Bank, which had been increasing in the recent years, decreased to about half their average values in 1951, a

change possibly to be associated with a decrease in the fishing intensity of the Danish cutter fleet and/or the rich growth of *Alcyonidium* in 1951.

In the north-west of the area the principal year-classes of plaice caught by the Scottish research vessels outside the recognised nursery grounds belonged to the 1948, 1947, and 1946 year-classes.

**Rare Fish:** Records of unusual fish were numerous during 1951, the principal features being (a) the large number of specimens obtained in July and August, (b) the number of sturgeons caught and (c) the more than average abundance of Ray's Bream.

Pelagic fish statistics etc. will be found in the reports presented to the Chairman of the Herring Sub-Committee.

C. E. LUCAS.

## ENVIRONMENT

### Hydrography.

#### Northern North Sea and Approaches.

Except for a more intensive summer cruise to the west of the British Isles, covering the region from beyond the chain of banks from Faroe Bank to Porcupine Bank to the western shores of Scotland and Ireland, the regions in which Scottish research vessels operated during 1951 were as in 1950. The overall intensity of hydrographic work during the year is given by Table 1.

Compared with 1950, the number of hydrographic stations occupied was greater by 100 per cent., temperature and salinity observations were increased by 50 per cent., oxygen observations also by 50 per cent. and so on throughout the several sections of hydrographic work except in respect of drift-bottle liberations where the output, on account of a re-orientation of the total effort to embrace more intensive localised investigations, was very slightly below that

of 1950. The return, however, was a little greater, nearly 11 per cent. as compared with  $9\frac{1}{2}$  per cent. in the previous year. The frequency distribution of the 1951 recoveries is given in Table 2 constructed on the same basis as Table 1 of the 1950 report (q.v.)<sup>1</sup>.

<sup>1</sup> Ann. Biol. Vol. VII (1950) p. 69. For convenience, the significance of the numerical sub-division of recoveries in Table 2 and subsequent tables is repeated here: - 0<sup>1</sup> = France; 0 = Ireland and W. England; 1 = the Outer Hebrides and W. coast of Scotland; 2 = N. coast of Scotland and W. coasts of Orkney and Shetland; 3 = east coasts of Orkney and Shetland; 4 = Moray Firth shores; 5 = E. Scottish coast, Rattray Hd. to St. Abb's Hd.; 6 = St. Abb's Hd. to latitude 54°N. on English coast; 7 = English coast S. of latitude 54°N.; 8 = coasts between Texel Island and mouth of R. Elbe, Germany; 9 = mouth of R. Elbe to Blaavandshuk, Denmark; 10 = Blaavandshuk to Hanstholm; 11 = Skagerrak and Kattegat shores between Hanstholm and Lindesnaes; 12 = Lindesnaes to latitude 62°N. on Norwegian coast; 13 = Norwegian coast from latitude 62°N. to latitude 70°N.; 14 = Norwegian coast N. of latitude 70°N.; 15 = at sea; 16 = the Faroe Islands; 17 = Iceland.

Table 1. Scottish Hydrographic Operations 1951.

| Research Vessel  | No. of Hydrographic Stations | No. of Temperature Observns. | No. of Salinity Observns. | No. of Oxygen Observns. | No. of Phosphate Observns. |                 | No. of pH Observns. | Drift Bottles |           |          |
|------------------|------------------------------|------------------------------|---------------------------|-------------------------|----------------------------|-----------------|---------------------|---------------|-----------|----------|
|                  |                              |                              |                           |                         | Free Phosphate             | Total Phosphate |                     | No. Libtd.    | No. Recd. | R %<br>L |
| "Scotia".....    | 428                          | 3847                         | 3861                      | 1118                    | 1112                       | 184             | 369                 | 735           | 68        | 9.3      |
| "Explorer".....  | 441                          | 3407                         | 3406                      | 612                     | 621                        | 43              | —                   | 865           | 177       | 20.5     |
| "Clupea".....    | 797                          | 3045                         | 3040                      | 498                     | 599                        | 12              | —                   | —             | —         | —        |
| "Kathleen".....  | 64                           | 226                          | 226                       | —                       | —                          | —               | —                   | —             | —         | —        |
| Weather Ships... | —                            | —                            | —                         | —                       | —                          | —               | —                   | 1100          | 47        | 4.3      |
| Total.....       | 1730                         | 10525                        | 10533                     | 2228                    | 2332                       | 239             | 369                 | 2700          | 292       | 10.8     |

No recovery on the French coast was recorded in 1951, nor, although this is not specifically shown in Table 2, on the west coast of England. Irish coast recoveries were numerically almost the same in 1951 as in 1950, but fewer returns came from the western Scottish including Orkney and Shetland shores. Recoveries on the east coasts of Scotland and England would appear to have been significantly greater in the later year, and one of these occurred in a more southerly position than before.

On the other side, the east side, of the North Sea, Skagerak recoveries were proportionately greater in 1951, and also Norwegian coast strandings outwith the North Sea.

Subdivision of Table 2 with respect to regions of liberation gives further point to at least some of the above differences and reveals others.

In Table 3 are given the data pertaining to liberations at and *en route* to Weather Station J in latitude 52°N., longitude 20°W.

The much smaller proportionate return from liberations in respect of Weather Station J in 1951 as compared with 1950 is very largely accounted for by the relatively small number of Irish coast recoveries which took place in the later year. Practically all of them, by their drift-periods, indicate circuitous routes, probably on account of eddy influence, thus bearing out the evidence of the 1950 results that the region west of Ireland is dominated by a superficially large cyclonic eddy. It is interesting however to observe that one drifter from

this region reached the North Sea section of the Norwegian coast. So also did a single bottle from the region of the Weather Station I liberations, the results from which are given in Table 4.

No less than three Irish coast strandings resulted from the Weather Station I liberations. This means that the bottles concerned had resultant drifts in a *southerly* direction from their liberation positions. The drift-periods in all three cases were almost the same—53, 55 and 57 days—although different seasons were involved. None suggests a direct course and in conjunction with other results from more southerly liberations, the probability is, as already mentioned, that cyclonic eddy influence off the west Irish coast accounted for significant amounts of the total drift-periods. Two of the drifters were found in April on the mid-west, and the third in August on the north-west, Irish coastline. The two first originated in February at two positions in the region of Rockall Bank, between latitudes 57°N. and 57°30'N., longitudes 12°W. to 14°W., and the third in June from one of these same positions.

The Irish coast recoveries from the Weather Ships' liberations account for only one half (19) of the total number (38) of Irish recoveries in 1951, as can be seen by comparing Tables 2, 3 and 4. Nine more west Irish returns came from research vessel liberations in the Weather Ship J region in the month of June. The remaining eight Irish strandings took place on the east coast in May, June and July from three series of liberations in May in the narrowest

Table 2. Scottish Surface Drift-Bottle Liberations 1951.

| Liberations (L) |                    |                        |    |    |    |    |    |   |   | Recoveries (R) |   |   |    |    |    |    |    |    |    |        |     |      |  |  |  |  | R<br>L % |
|-----------------|--------------------|------------------------|----|----|----|----|----|---|---|----------------|---|---|----|----|----|----|----|----|----|--------|-----|------|--|--|--|--|----------|
| Year            | No. of<br>Drifters | Frequency-Distribution |    |    |    |    |    |   |   |                |   |   |    |    |    |    |    |    |    | Totals |     |      |  |  |  |  |          |
|                 |                    | 0 <sup>1</sup>         | 0  | 1  | 2  | 3  | 4  | 5 | 6 | 7              | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |        | 17  |      |  |  |  |  |          |
| 1951            | 2700               | —                      | 38 | 18 | 16 | 24 | 10 | 9 | 3 | 1              | — | — | 1  | 29 | 44 | 85 | 4  | 2  | 3  | 5      | 292 | 10.8 |  |  |  |  |          |



Table 3. Weather Station J.

| Liberations (L) |                    | Recoveries (R) |    |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    | R<br>L % |        |
|-----------------|--------------------|----------------|----|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----------|--------|
| Year            | No. of<br>Drifters | 0 <sup>1</sup> | 0  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |          | Totals |
| 1951            | 495                | —              | 16 | 7 | 2 | — | — | — | — | — | — | — | —  | —  | 1  | 2  | —  | —  | —  | —  | 28       | 5.7    |

waters between Scotland and Ireland, between both the Mull of Galloway and the Mull of Kintyre and Northern Ireland. While nearby Irish strandings sometimes occur from liberations in these waters, the normal expectation is that they will occur on the western shores of Scotland, including the Orkney and Shetland Islands and, in isolated cases, in Norway. The 1951 results therefore would appear to be remarkable not merely in their occurrence well to the southward of the respective liberation positions, but in reaching so far south as the neighbourhood of Dublin. They indicate strong *southerly* currents during the summer months of May, June, and July through the channels separating Scotland from Ireland, that is, in the opposite direction from that in which they are usually found to run. These results also and their interpretation as just given are doubtless linked with the records above considered of west and north-west Irish strandings resulting from February and June liberations in the Rockall area. These findings represent more or less radical departures from the former understanding of current conditions in the seas off the western British Isles and seem to support in substantial measure the deductions recently made by COOPER<sup>1</sup>) in respect of this region.

Note may be made in passing of the two Moray Firth coast recoveries from Weather Ship liberations between Scotland and Rockall. These occurred in the month of May and originated from liberations made in January. It is also remarkable in comparison with 1949 and 1950 that only a single west Scottish coast return came from liberations associated with Weather Station I. The overall set of the surface drift towards the western Scottish seaboard from the open ocean seems therefore to have

been very much less in 1951 than in the previous two years. Northerly Norwegian coast recoveries, which might have been expected in consequence to bulk larger among the 1951 returns from the Weather Ships' liberations, do not in fact fulfil the expectation. Consideration of the results from the Faroe-Shetland Channel region may throw light on this issue. These are given in Table 5.

Clearly the proportion of northerly Norwegian recoveries from the Faroe-Shetland liberations of 1951 is high. There must therefore have been an essential difference between the main current direction in the Faroe-Shetland Channel and that in the region south of the Wyville Thomson Ridge. The key to the difference would seem to be given by the Irish coast recoveries already noted from the Rockall Bank region, and also by those on the east coast of Ireland which suggest a strong south-easterly current from the open ocean towards and through the North Channel between Scotland and Ireland. From almost immediately south of the Wyville Thomson Ridge, over which the resultant trend of the water movement was evidently north-easterly, the current system, in the upper water layers at all events, had a strong southerly component during the spring and summer. By August this trend had begun to diminish and in the last quarter of the year several records appeared of recoveries on Orkney, Shetland and Norway from liberations south-west and west of Iceland which entailed minimum average drift-speeds of 8 to 10 miles per day. The earliest recoveries of the year from Faroe-Shetland Channel liberations, particularly those of February, also indicate relatively high speeds of drift of the order of about 8 miles per day, and a fairly strong flow round the North of Shetland into the northern North Sea. From about the month of May or June, however, the general speed of the drift seems to have declined throughout the summer

<sup>1</sup>) L. H. N. COOPER: "The Physical and Chemical Oceanography of the Waters Bathing the Continental Slope of the Celtic Sea". Journ. Mar. Biol. Assoc., XXX, No. 3. Feb. 1952.

Table 4. Weather Station I.

| Liberations (L) |                    | Recoveries (R)         |   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    | R<br>L % |    |       |     |
|-----------------|--------------------|------------------------|---|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----------|----|-------|-----|
| Year            | No. of<br>Drifters | Frequency-Distribution |   |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |          |    |       |     |
|                 |                    | 0 <sup>1</sup>         | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16       | 17 | Total |     |
| 1951            | 605                | —                      | 3 | 1 | 7 | — | 2 | — | — | — | — | — | —  | —  | 1  | 4  | 1  | —  | —        | —  | 19    | 3.1 |

Table 5. Faroe-Shetland Channel Liberations 1951.

| Liberations (L) |                    | Recoveries (R) |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    | R<br>—<br>L % |
|-----------------|--------------------|----------------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|---------------|
| Year            | No. of<br>Drifters | 1              | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |               |
| 1951            | 425                | —              | 3 | 5 | — | — | — | — | — | — | —  | —  | —  | 28 | 2  | —  | 3  | —  | 41            |
|                 |                    |                |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    | 9.6           |

until the autumn when a resurgence of oceanic influence into and through the Faroe-Shetland Channel is indicated.

Results of the North Sea liberations of 1951 are given in Table 6.

The earliest drift-bottle liberations of the year 1951 in the northern North Sea, in February, resulted in some fairly quick returns from east Shetland and Orkney and the Moray Firth. The quickest return from Shetland from a liberation position some 60 miles east of Shetland in latitude 60°N. indicates a drift-speed of the order of 12 miles per day suggesting a strong flow of oceanic water into the northern North Sea from the Faroe-Shetland Channel. The remainder of the recoveries mentioned, in conjunction with others from later liberations, give unmistakable indication of an anticyclonic circulation dominating the north-western North Sea region from the Moray Firth to east Shetland waters. Some of these recoveries took place to the north and others to the south of their positions of liberation, demonstrating the closure to any effective oceanic incursion of the seaways between Shetland and the mainland of Scotland.

There seems little doubt that the speed of the surface drift slackened somewhat after about mid-March, but four significant recoveries on the English coast to below latitude 54°N. in the first half of June suggest a revival in oceanic influence from the north about that period. The inference is supported by six recoveries within the Firths of Forth and Tay in the same period from April liberations in the region between Fair Isle and the outer Moray Firth.

As Table 6 shows there was no correspondingly southerly recovery on eastern North Sea shores in 1951. The single entry in column 10 might almost be included in column 11 denoting Skagerak recoveries. These took place chiefly in the months of December 1951 and

January 1952 and originated from liberations in all months from February to November inclusive in which North Sea liberations were made. The concentration of these Skagerak strandings in the months of December and January was associated with similar concentrations on the Norwegian coast both within and without the North Sea, especially in December. Immediately beyond the North Sea, between latitudes 62°N. and 70°N., there was an earlier concentration of strandings in October, followed by a slight but definite diminution in November. The reading of these circumstances is that, after a summer lull in the intensity of the oceanic incursion into the Northern North Sea, this began to revive again towards the end of September, its influence being first evident along the Norwegian coast just beyond the North Sea. The climax of the incursion probably occurred in December when its maximum influence was felt from the Skagerak to the far north of Norway. This reading is supported by a number of short-period drift-bottle records which in turn are supported by others associated with them in time and course.

Mention has already been made of outstanding February records indicating a speed of drift during February and March of approximately 12 miles per day associated with the intensity of oceanic influence emanating immediately from the Faroe-Shetland Channel. Several records embracing the next three to four months show that the average drift speed of the surface currents in the regions investigated declined to between 7 and 8 miles per day. Thereafter, certain unique records from the west of the Outer Hebrides to Shetland gave minimum average drift-speeds of about 10 miles per day; October records from the central North Sea to the Norwegian coast yielded estimates of over 11 miles per day, and, finally, a significant short-period December result from the north-eastern North Sea to Norway over a

Table 6. North Sea Liberations 1951.

| Liberations (L) |                    | Recoveries (R) |   |    |   |   |   |   |   |   |    |    |    |    |    |    |    |    | R<br>—<br>L % |
|-----------------|--------------------|----------------|---|----|---|---|---|---|---|---|----|----|----|----|----|----|----|----|---------------|
| Year            | No. of<br>Drifters | 1              | 2 | 3  | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |               |
| 1951            | 900                | —              | 2 | 17 | 9 | 8 | 3 | 1 | — | — | 1  | 31 | 41 | 47 | 1  | —  | —  | 1  | 162           |
|                 |                    |                |   |    |   |   |   |   |   |   |    |    |    |    |    |    |    |    | 18            |

direct course bespoke a mean drift-speed of not less than  $12\frac{3}{4}$  miles per day.

Consideration of temperature-salinity distribution, particularly in the Northern North Sea, and of hydrodynamical computations in respect of the Faroe-Shetland Channel region, support the foregoing interpretations of drift-bottle results. A strong penetration of high salinity ( $>35.30\text{‰}$ ) oceanic water into the northern North Sea, with even stronger Atlantic characters immediately north of Shetland, was evident in mid-February. By the month of April and on the evidence of lower average salinity, the incursion had weakened to some extent although still penetrating well down into the North Sea on its western side.

In May an estimate of the strength of the North Atlantic Drift Current in the Faroe-Shetland Channel gave the very low figure of only about 4 cubic kilometres per hour across a section normal to the direction of the current. By July this intensity had declined still further to little more than half of the above figure and in this same month, over almost the whole of the northern North Sea area, except for a narrow margin on the west side, oceanic water was overlaid by a layer of 20 to 30 metres' thickness of fresher water obviously deriving from the Norwegian side of the region.

Although less markedly fresh, this overlay of the oceanic water mass was still in evidence in early September in the lower reaches of the northern North Sea, between latitudes  $58^{\circ}\text{N}$ . and  $59^{\circ}\text{N}$ . A month later it had practically disappeared from the same region and by November recovery of the oceanic influence from surface to bottom was recorded. In December the whole water mass between latitudes  $60^{\circ}\text{N}$ . and  $61^{\circ}\text{N}$ . from Shetland to longitude  $3^{\circ}\text{E}$ . was again strongly oceanic in character. As the drift-bottle results show this resurgence of oceanic influence at the end of the year obviously carried over into the first two months of 1952.

J. B. TAIT.

### Hydrography of the Firth of Forth in the Spring.

From a study of a considerable number of pre-war observations in the Firth of Forth, the

writer reached the following tentative conclusions:

- (i) A main sea water inflow takes place through the centre of the May Island/Bass Rock channel.
- (ii) There is a belt of very low salinity surface water extending five or six miles from the south shore of the Firth. This represents the discharge to the sea of the rivers entering the upper Firth.
- (iii) Between the May Island and the north shore the surface water is of low salinity, and this is due to the movement of water from the River Tay around Fifeness. This Tay influence does not generally extend west of  $2^{\circ}40'\text{W}$ . and the water of Largo Bay shows no vertical salinity gradient.

A series of brief hydrographic surveys has been carried out during the early spring of 1951 and 1952 in order to check these suppositions. The Firth of Forth ceased to be a herring spawning ground during the war and it is hoped by means of annual surveys of this type to detect the significant hydrographic factor should spawning take place again. In 1951 two surveys were carried out and in 1952 a single more extended survey. The distribution of surface and bottom properties is shown in the figure.

It will be seen that this appears to support the general description given above, with the added detail that the warmest and most saline water, which we take to represent the principal inflow to the Firth, lies near the bottom between three and eight miles from the south shore. It is in fact overlaid to some extent by relatively fresh outflowing water above it. There is a strong suggestion of a parallel inflow immediately south of the May Island, of water of rather lower salinity. The large variability in hydrographic conditions makes it clear that (a) generalization from a few surveys is of limited value (b) that variation in *biological* conditions over short periods and distances is to be expected.

The zones of river influence are characterised by high phosphate and total phosphorous values both at surface and bottom, and by oxygen values slightly above the mean.

R. E. CRAIG.





Figure 1. Distribution of properties in the Firth of Forth, January 1951 and 1952.

Temp. (°C), Salinity (‰), Phosphate (P<sub>μ</sub>, μg. atoms/litre), Total P. (μg. atoms/litre), Oxygen (ml at N.T.P. per litre).

direct course bespoke a mean drift-speed of not less than  $1\frac{3}{4}$  miles per day.

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From a study of considerable number of pre-war observations in the Firth of Forth, the

writer reached the following tentative conclusions:

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- (iii) Between the May Island and the north shore the surface water is of low salinity, and this is due to the movement of water from the River Tay around Fifeness. This Tay influence does not generally extend west of  $2^{\circ} 40'$  and the water in Largo Bay shows no vertical salinity gradient.

A series of brief hydrographic surveys has been carried out during the early spring of 1951 and 1952 in order to check these suppositions. The Firth of Forth ceased to be a herring spawning ground during the season and it is hoped by means of annual surveys of this type to detect the significant hydrographic factor should spawning take place again. In 1951 two surveys were carried out and in 1952 a single more extended survey. The distribution of surface and bottom properties is shown in the figure.

It will be seen that this appears to support the general conclusion given above. The added detail that the warmest and most saline water, which we take to represent the principal inflow to the Firth, lies near the bottom between three and eight miles from the south shore. It is in fact overlaid to some extent by relatively fresh outflowing water above it. There is a strong suggestion of a parallel inflow immediately south of the May Island, of water of rather lower salinity. The large amount of data in hydrographic conditions makes it difficult to generalize from a few surveys is of limited value (b) that variation in biological conditions over short periods and distances is to be expected.

The zones of river influence are characterised by high phosphate and total phosphorous values both at surface and bottom, and by oxygen values slightly above the mean.

R. E. CRAIG.



Figure 1. Distribution of properties in the Firth of Forth, January 1951 and 1952.  
 Temp. ( $^{\circ}\text{C}$ ), Salinity ( $\text{‰}$ ), Phosphate ( $\text{PO}_4\text{-P}$  in  $\mu\text{g-atoms/litre}$ ), Total P. ( $\mu\text{g-atoms/litre}$ ), Oxygen (ml. at N.T.P. per litre).



**Table 7. Monthly Means of Salinity and Temperature at Surface and Bottom at the Lightvessel "Vyl" for a longer Series of Years, and Anomalies from these Means.**

(From the Danish Meteorological Institute, Nautical Department.).

| Month:             | I    | II   | III  | IV   | V    | VI             | VII  | VIII | IX   | X    | XI   | XII  |
|--------------------|------|------|------|------|------|----------------|------|------|------|------|------|------|
| <b>Salinity</b>    |      |      |      |      |      | <b>Surface</b> |      |      |      |      |      |      |
| Mean.....          | 32.6 | 32.4 | 32.2 | 32.4 | 32.3 | 32.6           | 32.5 | 32.4 | 32.6 | 32.4 | 32.4 | 32.9 |
| 1951.....          | 0.9  | 1.4  | —    | —    | —0.4 | 0.0            | 0.2  | 0.6  | 0.6  | 1.0  | 0.7  | 0.4  |
|                    |      |      |      |      |      | <b>Bottom</b>  |      |      |      |      |      |      |
| Mean.....          | 33.0 | 32.8 | 32.7 | 32.8 | 32.6 | 33.1           | 32.9 | 32.7 | 32.8 | 32.6 | 32.7 | 33.0 |
| 1951.....          | 1.0  | 1.4  | —    | —    | 1.1  | 0.3            | 0.2  | 0.7  | 0.8  | 1.2  | 0.8  | 0.7  |
| <b>Temperature</b> |      |      |      |      |      | <b>Surface</b> |      |      |      |      |      |      |
| Mean.....          | 3.2  | 2.2  | 2.6  | 4.8  | 8.8  | 12.4           | 15.2 | 16.1 | 15.0 | 12.2 | 8.5  | 5.4  |
| 1951.....          | 0.6  | 0.7  | 0.5  | 0.2  | 0.2  | 0.4            | —1.0 | 0.2  | 1.1  | 1.4  | 2.0  | 2.4  |
|                    |      |      |      |      |      | <b>Bottom</b>  |      |      |      |      |      |      |
| Mean.....          | 3.9  | 2.6  | 3.0  | 4.7  | 7.9  | 11.1           | 14.1 | 16.0 | 15.2 | 12.7 | 9.0  | 6.2  |
| 1951.....          | 0.4  | 0.7  | 0.4  | 0.3  | —1.1 | —1.5           | —0.3 | —0.1 | 1.0  | 1.2  | 1.8  | 1.8  |

HELGE THOMSEN.

## Plankton.

### The Continuous Plankton Recorder Survey: The Plankton round the north of the British Isles in 1951.

During 1951 the Continuous Plankton Recorder Survey round the British Isles was continued as in previous years. These notes and figures are made available for comparison with the similar ones included in *Annales Biologiques* V, VI and VII (Northern North Sea). The intention as before is to give a broad summary of the relative conditions in the successive years rather than any detail of the distribution of the plankton; more detailed accounts will be published in the *Hull Bulletins of Marine Ecology* from time to time<sup>1)</sup>.

Fig. 2 shows the arrangement of the routes on which the Recorder was towed during 1951 and, although there are inevitable gaps in the data because of the sailing schedules of the Weather Ships and those commercial vessels which were generous enough to co-operate in the Survey, it is practicable to include in the summaries the south to north sequences of

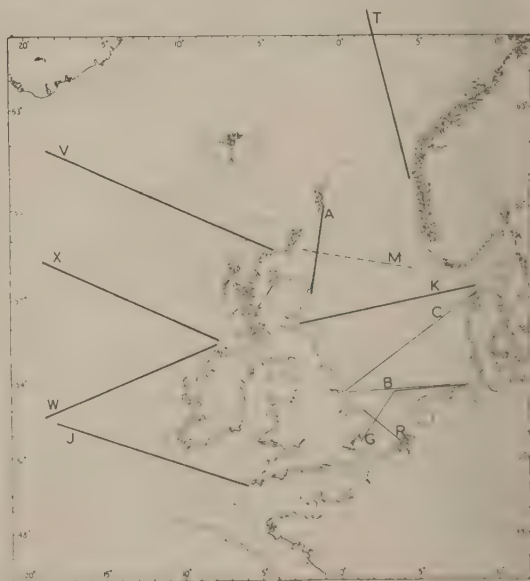
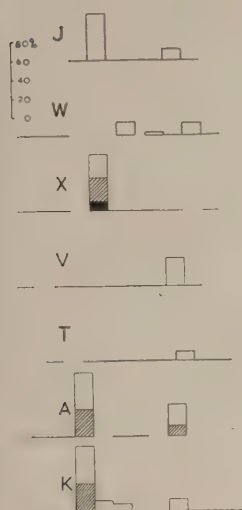


Figure 2. A chart showing the routes along which the Continuous Plankton Recorder was usually towed monthly during 1951. The routes indicated by the heavier line, i.e., J, W, X, V, T, A, and K, are those selected for this summary. M, indicated by a broken line, was only available for part of the year. The dotted line marks the position of the 200-fathom contour.

<sup>1)</sup> The Continuous Plankton Recorder Survey is now conducted by the Scottish Marine Biological Association and on completion of Volume III the Hull Bulletins of Marine Ecology will assume a new title, which has yet to be decided, and will be published by the Association in the same format.

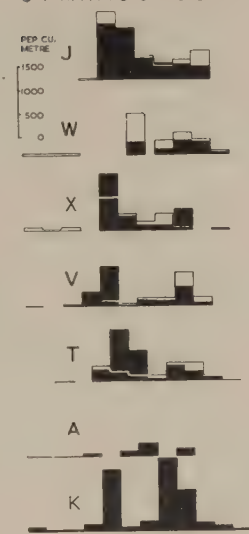
J F M A M J J A S O N D



J F M A M J J A S O N D

Figure 3.

J F M A M J J A S O N D



J F M A M J J A S O N D

Figure 4.

Figure 3. An estimate of the density of *Phytoplankton* month by month on the Recorder routes, J, W, X, V, T, A, and K. The histograms show the percentage of the route which sampled water containing various quantities of phytoplankton as estimated by comparing the colour of the filtering silk with an arbitrary colour scale. The open part of the histogram represents "pale green", the hatched part "green" and the blacked part "dark green". A gap in the base line indicates that no data were available in the particular month.

Figure 4. Histograms representing the relative numbers of *Total Copepoda* (all species combined) taken month by month on the Recorder routes J, W, X, V, T, A, and K. The values represent the number of copepods per cubic metre either for the whole length of tow on lines A and K or for the two parts of the tow which lie on either side of the 200-fathom contour on lines J, W, X, V, and T when the solid histogram shows the numbers over the deeper water and the open histogram over the shallower or coastal water. A gap in the base line indicates that no data were available in the particular month.

the routes in the Atlantic ('J', 'W', 'X', 'V' & 'T') and the two North Sea routes ('A' & 'K'). Except in the case of the 'M' route, on which only three tows were obtained, information is available for most months from the other North Sea routes, although it is not presented here.

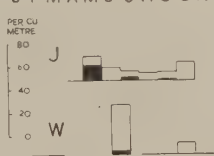
A very gross estimate of total phytoplankton, based on the proportion of the record which was coloured green, is shown in Fig. 3. Although the extent of 'green-ness' is somewhat less than in previous years the histograms bring out again the two well defined crops of phytoplankton; the first in April/May and the second

in September/October. On neither of the two northerly routes, 'V' & 'T', was there a detectable spring flowering.

The total copepods (Fig. 4) showed for the first time a spring maximum over the deep waters on the Atlantic routes in May, largely due to *Pseudocalanus* and *Oithona*, while the dense summer population of *Acartia* found over the deep water in August and September 1948 and 1949 did not materialise and in this 1951 was similar to 1950. On the 'K' route, as in previous years, there was evidence of two maxima in the copepod population, one in spring and one in late summer.

It appears to have been a good year for *Calanus* (Figs. 5 and 6) and the histograms bring out well the northerly distribution of this species in the area. In comparing the figures for the large stages of *Calanus* (V and adults) it should be noted that the scale used is that adopted in previous years only for those parts of the Atlantic routes which sample over the

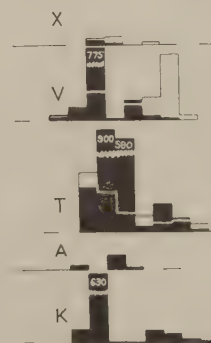
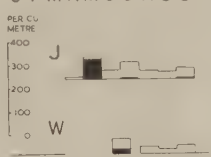
J F M A M J J A S O N D



J F M A M J J A S O N D

Figure 5.

J F M A M J J A S O N D



J F M A M J J A S O N D

Figure 6.

Figure 5. Histograms representing the relative numbers of *Large Calanus* (copepodid stages V and VI) taken month by month on the Recorder routes J, W, X, V, T, A, and K. Details as in Figure 4.

Figure 6. Histograms representing the relative numbers of *Calanus* (all stages combined) taken month by month on Recorder routes J, W, X, V, T, A, and K. Details as in Figure 4.

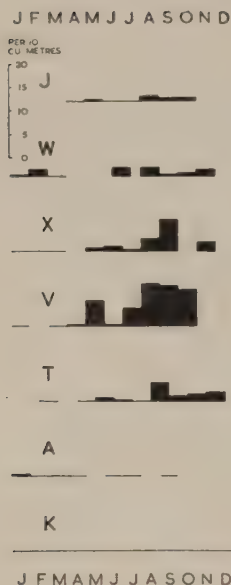


Figure 7.

Figure 7. Histograms representing the relative numbers of *Euchaeta* spp. taken month by month from the Recorder routes J, W, X, V, T, A, and K; only that part of the tow taken outside the 200-fathom contour is included on routes J, W, X, V, and T. By far the majority of the copepods are *E. norvegica* although a few *E. acuta* and *E. hebes* are included.

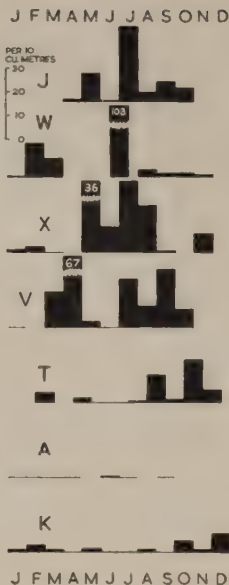


Figure 8.

Figure 8. Histograms representing the relative numbers of *Metridia lucens* taken month by month from the Recorder routes J, W, X, T, V, A, and K; only that part of the tow taken outside the 200-fathom contour is included on routes J, W, X, V, and T.

shallow coastal waters. This becomes necessary because of the relatively high numbers found over the deeper sections of the 'V' and 'T' routes, which far exceed those taken elsewhere in the area.

*Pleuromamma* and *Candacia* are not figured in this series; their seasonal distribution is so like that consistently found in the three previous years. *Pleuromamma* occurred on the Atlantic lines ('J', 'W', 'X' & 'V') in small numbers only during the summer and increased in the autumn; it was only between August and November that relatively high densities of the order of 5 per cu. metre were encountered. *Candacia* was found over the deeper part of the 'J' route from May to October and was taken on 'W' and 'V' only in October. It made its usual appearance on 'K' from October to December in association with *Metridia*. Again, as in earlier years, the evidence suggests that on

the western seaboard its distribution is essentially coastal, within the 200 fathom contour, and although it is carried southwards in the North Sea at the time of the autumnal influx of Atlantic water it only does so as a result of the mixing of this water with coastal waters rather in the same way as *Sagitta elegans*.

*Euchaeta* spp. (Fig. 7) were largely *E. norvegica*, except for a few *E. hebes* found on the more southerly Atlantic routes. *E. norvegica* was found mainly in the autumn and was most abundant on the 'V' route. It is interesting to note, however, that on the 'V' route there was a peak earlier in the year, in May, as was the case in 1948 when data were last available from this route. The occurrence of *Euchaeta* on the 'A' route, where it was taken in January, is unusual at 10 m. depth, although it was also found in considerable numbers on the 'M' line (not illustrated) over the Great Fisher Bank in November.

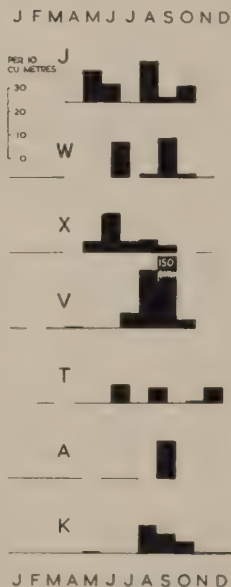


Figure 9.

Figure 9. Histograms representing the relative numbers of *Limacina* (only those individuals larger than 1 mm. included) taken month by month from the Recorder routes J, W, X, T, V, A, and K; only that part of the tow taken outside the 200-fathom contour is included on routes J, W, X, V, and T.

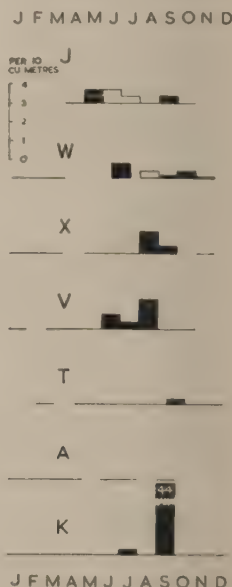


Figure 10.

Figure 10. Histograms representing the relative numbers of *Clione limacina* (solid) and *Clione clione* (open line) taken month by month from the Recorder routes J, W, X, V, T, A, and K; only that part of the tow taken outside the 200-fathom contour is included on routes J, W, X, V, and T.



As in 1950 one can interpret the histograms for *Metridia lucens* (Fig. 8) in terms of the Atlantic drift. The two peaks found on 'J' and 'X' in May and July can be identified with those of 'V' in July and September, with those on 'T' in August/September and October/November and with those on 'K' in October/December, whilst the concentration on 'W' in February/March can be related to that on 'V' in March/April and to the small numbers on 'T' in April/May and on 'A' in May. There is also a left to right swing in the histograms for the pteropods, *Limacina* (Fig. 9) and *Clio* and *Clione* (Fig. 10) and for *Tomopteris* (Fig. 11), as one reads down the page, although the sequence is not so marked as in the case of *Metridia lucens*, if the interpretation suggested above is valid; the time interval is shorter. However, if one looks back over the histograms

presented for the last four years the apparent time lag between the period, or periods, of maximum concentrations of the various indicator forms illustrated, *Metridia*, *Limacina*, *Clione*, *Tomopteris* and *Thaliacea*, is surprisingly consistent, especially if one considers the very broad method of presentation. It is beyond the scope of these notes to discuss whether this is due to a seasonal lag in breeding periods from the south to north or whether it is due to a physical translation of individuals in the residual water movements as is probably so in the case of the doliolids. We hope, however, that it will be possible for us to give a more detailed consideration to this point in the near future when charts of the spatial distribution of the various forms can be shown.

The *Thaliacea* were particularly abundant in 1950 and then it was possible to trace their apparent movement from the southern Atlantic lines northwest to the 'T' route and into the North Sea to the 'A' route. In 1951 again (Fig. 12) fair numbers were taken on 'J' from May until July but apparently they failed to survive in the northwest drift as well as they did in the previous year. The numbers in which they occurred in June and July on 'W' and 'X' is consistent rather with the results for 1948 and 1949 and although few were found on the 'V' line some reached the northwestern coastal waters ('T' shallow) in the late autumn. None were taken in the North Sea. It may be significant, however, that from August to November a few specimens were taken in the coastal waters, to the coastal side of the 200 fathom contour on 'J', 'W' and 'X', where they had not been caught by the Recorder in previous years. This is the first year in which data have been available from the 'J' route during the summer months and it is interesting that, whereas the *Thaliacea* were found well towards the western end of the route from May to July, thereafter they appeared to move progressively towards the mouth of the channel until in October the centre of distribution was to the east of the 200 fathom contour. There was some suggestion that other indicator forms, *Metridia* and *Limacina*, behaved in a similar manner. It may prove possible with future years' information at our disposal to trace the drift into the western reaches of the channel as well as northwards into the northern North Sea.

K. M. RAE.

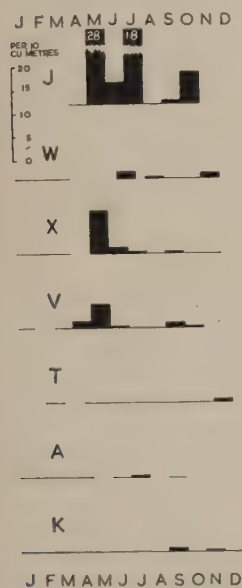


Figure 11.

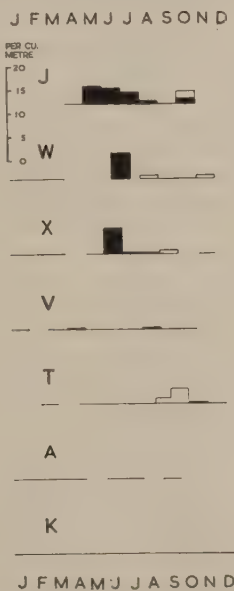


Figure 12.

Figure 11. Histograms representing the relative numbers of *Tomopteris* taken month by month on Recorder routes J, W, X, V, T, A, and K; only that part of the tow taken outside the 200-fathom contour is included on the routes J, W, X, V, and T.

Figure 12. Histograms representing the relative numbers of *Thaliacea* taken month by month on Recorder routes J, W, X, V, T, A, and K. On routes J, W, X, V, and T the solid histogram shows the numbers over the deeper water, outside the 200-fathom contour, and the open histogram those over the shallower or coastal water.

### Scottish Plankton Investigations, 1951.

The research vessels "Explorer", "Scotia", "Clupea" and "Kathleen" were working in the Northern North Sea for a considerable part of the year and plankton samples were taken during the cruises using the International Standard fine-silk net, Hensen egg-net, and 1 and 2-metre ring nets.

The main increase of phytoplankton did not begin until April—when rich collections were taken, especially in the N.E. area, the dominant species being *Thalassiothrix nitzschoides* and *Rhizosolenia shrubsolei*—and not until May in and near the Moray Firth where the dominant species were *Thalassiosira gravida*, *Nitzschia seriata*, *Asterionella* and *Lauderia*. By late summer and autumn dinoflagellates predominated over the whole North Sea area. *Ceratium tripos* was especially abundant in the northwest and was mixed with *C. furca*, *C. fusus*, *C. horridum* and *C. macroceros* further south. The autumn increase of diatoms was very evident in the Moray Firth where *Th. gravida*, *Guinardia*, *Coscinodiscus* and *Chaetoceros* species were taken in abundance.

The zooplankton of the Moray Firth in spring showed evidence of an influx of *Sagitta serratodentata* from the area off the north coast of Scotland round the Orkney Islands, an influx which is confirmed by the early distribution of *Laodicea* from the north and west Scottish coasts penetrating also to the Moray Firth area. This same influx brought conditions which were favourable to the development of indigenous *Calanus finmarchicus* which became much richer there than in the neighbouring areas of Fladen, Fair Isle and east of Aberdeen where *Calanus* was not found abundantly until July, August and September. *Calanus* was, however, very abundant indeed in early summer in the Faroe area and on the continental shelf west of Scotland; nevertheless, the planktonic evidence indicates that, although *Calanus* became fairly plentiful in the northern North Sea in the middle and late summer, it appears to have been produced from a relatively small stock and had not been brought into the area *en masse* from outside. *Limacina retroversa* and *Clione limacina* were both plentiful in the north-western North Sea and although they were also common off the Butt of Lewis and west Scottish coasts, they were not taken in numbers off the north Scottish coast, Fair Isle or Shetland. The "indicator species" suggest that only part

of the water mass which was sampled when entering the Faroe Channel in May and June had reached the Faroe-Shetland line by July and August, and that little of this entered the North Sea between Shetland and Norway. (A further description of the plankton-hydrographical relationships in the Faroe Channel and adjacent waters is given in the N.W. area section of this volume). *Calanus helgolandicus* was not common during the first half of the year, but by October and November it was found in about the same numbers as *Calanus finmarchicus* over the Fladen, east and west Scottish coastal areas. *Euchaeta norvegica*, *Calanus hyperboreus* and *Metridia longa* were found over the Norwegian Deep in spring.

*Sagitta setosa* was widespread with *S. elegans* in the northern North Sea, reaching at least as far north as 60°N. and indicating mixed waters or a swirl in this area in the first half of the year. However, the numbers of oceanic species in the northern North Sea increased towards the end of the year and *Salpa fusiformis*, *Sagitta serratodentata* and *Rhincalanus* were brought as far as the Fladen area. *Sagitta setosa* was then much more restricted in its distribution, and *S. elegans* became more and more abundant further south and close to the east Scottish coast and at least as far as 55°30'N. by November.

It is now well known that in general the richest plankton in the North Sea occurs where there is a mixture of coastal and oceanic water and it is thus not surprising to find that the spring and early summer collections in the North Sea were poor in 1951 but became much richer in autumn. This is true not only of *Calanus*, *Limacina*, *Clione* and *Sagitta elegans* but also of medusae and euphausiids, etc. Medusae were well represented off the west Scottish coast in May (*Laodicea*, *Cosmetira*, *Hybocodon*, *Obelia*, *Mitrocomella*, *Cyanea*, etc. with abundant *Aglantha* in the open ocean) but only poorly represented in the northern North Sea except in the Moray Firth and over the Norwegian Deep. As mentioned above, *Laodicea* entered the Moray Firth early in the year via the Orkney passages and it was followed in June by *Cosmetira* and *Physophora* which reached the Aberdeenshire coast by July. By July they had also started to penetrate into the area east of Shetland together with *Mitrocomella* and *Thysanoessa longicaudata*, to be followed later by *Agalma elegans*, *Meganyctiphanes*, *Galettia* and *Hippo-*

*podius*, some of which reached the Fladen Ground in October and November, some two months or more later than their arrival off the Aberdeenshire coast.

Thus the planktonic conditions in the northern North Sea (but not the north-western Area) in 1951 resembled in general those of 1950 and are in contrast to 1949.

In the period April to August, 1951, hydro-biological investigations were carried out in and near the Moray Firth over the area of the Fraserburgh and Peterhead herring fishing grounds by Mr. T. LOVEGROVE. (The area selected was approximately 3,000 square miles). A grid of 74 stations was visited at fortnightly intervals when plankton samples were taken with the Hensen vertical net. The main object of these quantitative surveys was to determine any relationship between herring and plankton, plankton and hydrography, and the general plankton ecology of the area; but no conclusions can be reached until the analysis of samples is complete. Those collections already examined reveal the main plankton cycles during the period of sampling.

In the latter half of April the only organisms present in any abundance were diatoms, euphausiids and *Metridia lucens*.

In early May *Calanus* (stages V and VI) were abundant with *Metridia* and decapod larvae, but by late May no dense concentrations of any one organism were observed. In early June, however, sharp increases were shown by *Calanus* (stage I—IV), *Centropages typicus*, *Parapseudocalanus*, and medusae. *Oithona*, *Acartia* and euphausiids showed a slight increase. Fish eggs were numerous at this period, and *Pleurobrachia* was abundant over the whole of June. In the latter part of the month diatoms and *Metridia* increased but the increase in diatoms was only short lived.

By early July, dinoflagellates, *Temora*, *Acartia*, *Centropages hamatus*, *Oithona*, *Anomalocera* and copepod nauplii all showed a sharp increase. *Calanus* (stages V and VI) and *Centropages typicus* showed a second outburst and *Cladocera*, *Cyphonautes* larvae, *Tomopteris*, *Limacina* and young *Clione* became abundant. The analysis of samples taken after July has not yet been completed.

The main diatom genera present were *Rhizosolenia*, *Coscinodiscus*, *Chaetoceros* and *Biddulphia*: the dinoflagellates included mainly *Ceratium longipes*, *C. tripos*, *C. fusus*, *C. furca*, *C. macroceros* and *C. horridum*.

J. H. FRASER.

## THE FISH

### Haddock.

#### Scottish Investigations.

During 1951, the haddock population of the northern North Sea and western grounds has been sampled as in previous years by the F.R.S. "Explorer". Hauls of one hour's duration were carried out using an otter trawl with small mesh cover, and the haddock caught were measured and sexed, and scales were taken for subsequent age analysis.

#### Age Composition.

The age composition of haddock caught by "Explorer" during 1951 is shown in Table 8, expressed as numbers of each brood caught per 10 hours fishing in different areas, and during different seasons of the year.

The 1945 brood was still well represented in the fishery and, along with the 1947, 1948 and 1949 broods contributed the greater proportion of haddock landed from the North Sea by weight.

The 1948 brood was best represented in the northern area showing a northerly trend in distribution since 1949, when it was predominantly found in the central area, and 1950, when it was distributed fairly evenly over the northern, north central and central areas. A slight northerly shift was also apparent in the centre of density of the 1949 brood, which in 1950 was principally found in the north central and central areas, but in 1951 was chiefly found in the north and north central areas.

The 1946, 1944 and older broods were practically extinct, as shown both by the figures in



**Table 8. Age Composition of Haddock caught by F. R. S. "Explorer" in 1951.**

| Per 10 Hours Trawling.                        |               |               |                |               |                         |                    |               |                |                |                          |               |                                            |                |               |                                                     |
|-----------------------------------------------|---------------|---------------|----------------|---------------|-------------------------|--------------------|---------------|----------------|----------------|--------------------------|---------------|--------------------------------------------|----------------|---------------|-----------------------------------------------------|
| Month.<br>Hours<br>trawling<br>Year-<br>Class | Northern Area |               |                |               |                         | North Central Area |               |                |                |                          | Central Area  |                                            |                |               |                                                     |
|                                               | Jan./<br>Mar. | Apr./<br>June | July/<br>Sept. | Oct./<br>Nov. | All<br>months           | Jan./<br>Mar.      | Apr./<br>June | July/<br>Sept. | Oct./<br>Nov.  | All<br>months            | Jan./<br>Mar. | Apr./<br>June                              | July/<br>Sept. | Oct./<br>Nov. | All<br>months                                       |
|                                               | 11            | 14            | 3 <sup>1</sup> | 8             | 36<br>Weighted<br>Means | 15                 | 96            | 11             | 6 <sup>1</sup> | 128<br>Weighted<br>Means | 11            | 5 <sup>1</sup> / <sub>2</sub> <sup>1</sup> | 17             | 13            | 46 <sup>1</sup> / <sub>3</sub><br>Weighted<br>Means |
| 1950                                          | 1093          | 490           | 213            | 1090          | 785                     | 313                | 963           | 384            | 528            | 817                      | 105           | 96                                         | 251            | 144           | 168                                                 |
| 1949                                          | 934           | 270           | 690            | 270           | 508                     | 654                | 547           | 465            | 248            | 512                      | 114           | 122                                        | 125            | 183           | 138                                                 |
| 1948                                          | 434           | 446           | 170            | 148           | 353                     | 242                | 80            | 52             | 92             | 97                       | 23            | 7                                          | 35             | 40            | 30                                                  |
| 1947                                          | 45            | 64            | 60             | 15            | 47                      | 19                 | 3             | 1              | Nil            | 4                        | 3             | 4                                          | 2              | Nil           | 2                                                   |
| 1946                                          | 3             | Nil           | Nil            | Nil           | 1                       | 1                  | Nil           | Nil            | Nil            | Nil                      | Nil           | Nil                                        | Nil            | Nil           | Nil                                                 |
| 1945                                          | 71            | 110           | 10             | 14            | 68                      | 24                 | 3             | 4              | 8              | 6                        | Nil           | 2                                          | 3              | 6             | 3                                                   |
| 1944+                                         | 9             | 14            | 3              | Nil           | 9                       | Nil                | Neg.          | Nil            | Nil            | Nil                      | Nil           | Nil                                        | Nil            | Nil           | Nil                                                 |
| All ages                                      | 2589          | 1394          | 1146           | 1537          | 1771                    | 1254               | 1596          | 606            | 876            | 1436                     | 245           | 231                                        | 416            | 373           | 341                                                 |

| Hours<br>trawling<br>Year-<br>Class | Moray Firth and Orkney |                |      |     |                         | Firth of Forth |   |   |                |                         | Western Area |     |                |                |                         |
|-------------------------------------|------------------------|----------------|------|-----|-------------------------|----------------|---|---|----------------|-------------------------|--------------|-----|----------------|----------------|-------------------------|
|                                     | 31                     | 8 <sup>1</sup> | 19   | 8   | 66<br>Weighted<br>Means | 18             | — | — | 2 <sup>1</sup> | 20<br>Weighted<br>Means | —            | 35  | 6 <sup>1</sup> | 7 <sup>1</sup> | 48<br>Weighted<br>Means |
|                                     |                        |                |      |     |                         |                |   |   |                |                         |              |     |                |                |                         |
| 1950                                | 70                     | 37             | 109  | 6   | 70                      | Nil            | — | — | Nil            | Nil                     | —            | 50  | 32             | 99             | 55                      |
| 1949                                | 4                      | 40             | 114  | 14  | 41                      | Nil            | — | — | 35             | 4                       | —            | 1   | 90             | 31             | 17                      |
| 1948                                | 25                     | 27             | 73   | 11  | 37                      | Nil            | — | — | 30             | 3                       | —            | 13  | 45             | 7              | 16                      |
| 1947                                | 1                      | 5              | 4    | Nil | 2                       | 1              | — | — | —              | 1                       | —            | 4   | 15             | 1              | 5                       |
| 1946                                | Nil                    | Nil            | Nil  | Nil | Nil                     | Nil            | — | — | Nil            | Nil                     | —            | Nil | 1              | Nil            | Nil                     |
| 1945                                | Nil                    | 1              | 6    | 1   | 2                       | 3              | — | — | 5              | 3                       | —            | 12  | 20             | 4              | 12                      |
| 1944+                               | Nil                    | 3              | Neg. | Nil | Neg.                    | Neg.           | — | — | Nil            | Nil                     | —            | 3   | 2              | Nil            | 1                       |
| All ages                            | 100                    | 113            | 306  | 32  | 152                     | 4              | — | — | 70             | 11                      | —            | 83  | 205            | 142            | 106                     |

<sup>1</sup> Based on a small number of hour's fishing, and hence less representative than other figures.

Table 8 and by a limited number of samples of North Sea haddock collected from the Aberdeen fish market during October and November.

The 1951 brood was first represented in "Explorer's" trawl in July (Table 9) and was most densely distributed in the north central area during the remainder of the year, as was the 1950 brood towards the end of 1950. The average number per 10 hours fishing from all areas was 697 which is greater than any previous 0-group estimate since 1945.

#### Size Composition.

As in previous years, the largest haddock, *age for age*, were taken from the central area, whilst the smallest came from the deeper waters of the northern area (Table 10).

#### Commercial Fishery.

During 1951 there was an increase in the total weight of haddock landed by British steam

**Table 9.**  
**Distribution and Density of the 1951 Brood in "Explorer" Catches July to November 1951.**

| Area                  | No. of<br>fish | No. of<br>hours | per<br>10 hrs. |
|-----------------------|----------------|-----------------|----------------|
| Northern.....         | 73             | 11              | 66             |
| North Central.....    | 6,072          | 17              | 3,572          |
| Central.....          | 270            | 30              | 90             |
| Moray Firth.....      | 210            | 27              | 78             |
| Firth of Forth.....   | Nil            | 2               | Nil            |
| Western.....          | 341            | 13              | 262            |
| Total for All Areas.. | 6,966          | 100             | 697            |

trawlers from the North Sea (Table 11). This increase was actually confined to the area north of latitude 57°30' N., however, total landings from south of this latitude being lower than in 1950. Little change was seen in the catch per 100 hours fishing from each region.

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Table 10. Mean Lengths (cm.) and Standard Errors of Haddock of each Age-Group from the North Sea and Western Grounds—1951.

| Year-Class | Age | Month      | Northern |       |          | North Central |       |          | Central |       |          | Moray Firth and Orkney |       |          | Firth of Forth |       |          | West |       |          |
|------------|-----|------------|----------|-------|----------|---------------|-------|----------|---------|-------|----------|------------------------|-------|----------|----------------|-------|----------|------|-------|----------|
|            |     |            | Mean     | S.E.  | No. fish | Mean          | S.E.  | No. fish | Mean    | S.E.  | No. fish | Mean                   | S.E.  | No. fish | Mean           | S.E.  | No. fish | Mean | S.E.  | No. fish |
| 1951       | 0+  | July-Sept. | 14.5     | 0.393 | 19       | 11.6          | 0.179 | 128      | 10.7    | 0.195 | 90       | 10.4                   | 0.140 | 108      | —              | —     | —        | 12.6 | 0.452 | 23       |
|            | 0+  | Oct.-Nov.  | 14.7     | 0.209 | 54       | 17.1          | 0.202 | 5944     | 17.3    | 0.134 | 180      | 15.0                   | 0.142 | 102      | —              | —     | —        | 16.1 | 0.068 | 318      |
| 1950       | 0+  | Jan.-March | 17.3     | 0.040 | 1203     | 16.9          | 0.073 | 470      | 18.7    | 0.161 | 115      | 18.2                   | 0.108 | 216      | 21.0           | 2.500 | 1        | —    | —     | —        |
|            | 1+  | Apr.-June  | 19.1     | 0.059 | 686      | 20.6          | 0.014 | 9248     | 21.3    | 0.187 | 53       | 20.5                   | 0.348 | 30       | —              | —     | —        | 19.1 | 0.104 | 174      |
|            | 1+  | July-Sept. | 24.4     | 0.259 | 64       | 24.4          | 0.066 | 422      | 25.3    | 0.084 | 426      | 23.0                   | 0.119 | 208      | —              | —     | —        | 26.3 | 0.390 | 19       |
|            | 1+  | Oct.-Nov.  | 28.0     | 0.067 | 872      | 25.4          | 0.083 | 317      | 28.2    | 0.129 | 187      | 29.2                   | 0.583 | 5        | —              | —     | —        | 26.1 | 0.202 | 69       |
| 1949       | 1+  | Jan.-March | 26.1     | 0.073 | 1027     | 26.2          | 0.067 | 982      | 27.8    | 0.193 | 125      | 30.3                   | 0.498 | 12       | —              | —     | —        | —    | —     | —        |
|            | 2+  | Apr.-June  | 26.5     | 0.103 | 378      | 28.2          | 0.028 | 5247     | 30.2    | 0.262 | 67       | 29.3                   | 0.611 | 32       | —              | —     | —        | 29.6 | 0.927 | 5        |
|            | 2+  | July-Sept. | 30.6     | 0.153 | 207      | 29.9          | 0.166 | 182      | 33.0    | 0.194 | 213      | 31.8                   | 0.210 | 216      | —              | —     | —        | 32.4 | 0.314 | 54       |
|            | 2+  | Oct.-Nov.  | 34.1     | 0.162 | 216      | 31.3          | 0.183 | 149      | 35.0    | 0.192 | 238      | 34.4                   | 0.562 | 11       | 37.3           | 1.084 | 7        | 31.8 | 0.459 | 22       |
| 1948       | 2+  | Jan.-March | 31.3     | 0.412 | 477      | 32.2          | 0.158 | 363      | 35.4    | 0.664 | 25       | 39.4                   | 0.477 | 77       | —              | —     | —        | —    | —     | —        |
|            | 3+  | Apr.-June  | 31.8     | 0.108 | 625      | 33.8          | 0.081 | 766      | 35.0    | 2.500 | 4        | 41.0                   | 0.818 | 22       | —              | —     | —        | 35.8 | 0.558 | 44       |
|            | 3+  | July-Sept. | 34.5     | 0.403 | 51       | 33.8          | 0.325 | 57       | 41.3    | 0.502 | 60       | 39.5                   | 0.340 | 139      | —              | —     | —        | 36.7 | 0.629 | 27       |
|            | 3+  | Oct.-Nov.  | 36.3     | 0.350 | 119      | 36.3          | 0.408 | 55       | 41.1    | 0.571 | 52       | 40.7                   | 0.726 | 9        | 45.7           | 1.308 | 6        | 42.6 | 2.713 | 5        |
| 1947       | 3+  | Jan.-March | 35.8     | 0.469 | 49       | 37.8          | 0.786 | 29       | 41.3    | 2.729 | 3        | 48.0                   | 5.000 | 2        | 42.0           | 2.000 | 2        | —    | —     | —        |
|            | 4+  | Apr.-June  | 36.4     | 0.320 | 90       | 38.6          | 0.552 | 26       | 46.0    | 6.000 | 2        | 43.0                   | 1.291 | 4        | —              | —     | —        | 41.3 | 0.902 | 13       |
|            | 4+  | July-Sept. | 41.4     | 0.724 | 18       | 33.0          | 3.000 | 1        | 46.3    | 4.334 | 3        | 38.6                   | 1.658 | 8        | —              | —     | —        | 40.1 | 0.831 | 9        |
|            | 4+  | Oct.-Nov.  | 41.6     | 0.900 | 12       | —             | —     | —        | —       | —     | —        | —                      | —     | —        | —              | —     | —        | 48.0 | 3.000 | 1        |
| 1946       | 4+  | Jan.-March | 32.0     | 0.577 | 3        | 33.5          | 0.500 | 67       | —       | —     | —        | —                      | —     | —        | —              | —     | —        | —    | —     | —        |
|            | 5+  | Apr.-June  | —        | —     | —        | 43.0          | 0.913 | 172      | —       | —     | —        | —                      | —     | —        | —              | —     | —        | —    | —     | —        |
| 1945       | 5+  | July-Sept. | —        | —     | —        | —             | —     | —        | —       | —     | —        | —                      | —     | —        | —              | —     | —        | 42.0 | —     | 1        |
|            | 5+  | Jan.-March | 38.2     | 0.540 | 78       | 39.5          | 0.789 | 36       | —       | —     | —        | 56.0                   | —     | 1        | 47.0           | 1.447 | 6        | —    | —     | —        |
|            | 6+  | Apr.-June  | 39.5     | 0.337 | 154      | 41.4          | 0.860 | 29       | 56.0    | —     | 1        | 40.0                   | —     | 1        | —              | —     | —        | 47.4 | 0.792 | 43       |
|            | 6+  | July-Sept. | 40.0     | 0.282 | 3        | 37.2          | 1.975 | 4        | 49.6    | 0.927 | 5        | 41.8                   | 1.240 | 13       | —              | —     | —        | 44.2 | 1.532 | 12       |
| 1944       | 6+  | Oct.-Nov.  | 49.2     | 2.040 | 11       | 44.0          | 2.191 | 5        | 47.0    | 1.118 | 8        | 44.0                   | —     | 1        | 55.0           | —     | 1        | 49.3 | 3.481 | 3        |

Table 11. Landings of Haddock by British Trawlers from North Sea Regions in 1951.

|                 | North of Lat. 57°30'N. |                  |                        | Lat. 55°N. to 57°30'N. |                        |                  | South of Lat. 55°00'N. |                  |                        | All Areas <sup>1</sup> |                        |                  |
|-----------------|------------------------|------------------|------------------------|------------------------|------------------------|------------------|------------------------|------------------|------------------------|------------------------|------------------------|------------------|
|                 | Weight landed/100 cwt. | 100 hrs. fishing | Weight landed/100 cwt. | 100 hrs. fishing       | Weight landed/100 cwt. | 100 hrs. fishing | Weight landed/100 cwt. | 100 hrs. fishing | Weight landed/100 cwt. | 100 hrs. fishing       | Weight landed/100 cwt. | 100 hrs. fishing |
| Jan.-March..... | 683                    | 610              | 112.0                  | 107                    | 212                    | 212              | 17                     | 1769             | 1.0                    | 974                    | 2731                   | 35.7             |
| April-June..... | 676                    | 754              | 89.7                   | 196                    | 518                    | 37.8             | 25                     | 951              | 2.6                    | 1037                   | 2389                   | 43.4             |
| July-Sept.....  | 414                    | 532              | 77.8                   | 580                    | 863                    | 67.2             | 93                     | 1241             | 7.5                    | 1262                   | 2860                   | 44.1             |
| Oct.-Dec.....   | 736                    | 583              | 126.2                  | 633                    | 606                    | 104.5            | 52                     | 1296             | 4.0                    | 1693                   | 2648                   | 63.9             |

<sup>1</sup> Includes landings from unknown rectangles.

## Whiting.

### British Statistics.

Table 12 is presented as a summary of the landings by British steam trawlers during 1951. It is set out in the same form as for last year.

**Table 12. Landings of Whiting by British Steam Trawlers from North Sea, 1951.**

| Quarterly Period         | North of Latitude 57°30'N. |                      |                            | Latitude 55°N. to 57°30'N. |                      |                            |
|--------------------------|----------------------------|----------------------|----------------------------|----------------------------|----------------------|----------------------------|
|                          | Wt. landed<br>in 100 cwt.  | 100 hours<br>fishing | Wt. landed<br>per 100 hrs. | Wt. landed<br>in 100 cwt.  | 100 hours<br>fishing | Wt. landed<br>per 100 hrs. |
| January to March.....    | 732                        | 610                  | 120                        | 32                         | 212                  | 15                         |
| April to June.....       | 522                        | 754                  | 69                         | 82                         | 518                  | 16                         |
| July to September.....   | 468                        | 532                  | 88                         | 187                        | 863                  | 22                         |
| October to December..... | 761                        | 583                  | 131                        | 258                        | 606                  | 43                         |
| Year.....                | 2,483                      | 2,479                | 100                        | 561                        | 2,199                | 26                         |

| Quarterly Period         | South of Latitude 55°N.   |                      |                            | All Areas <sup>1)</sup>   |                      |                            |
|--------------------------|---------------------------|----------------------|----------------------------|---------------------------|----------------------|----------------------------|
|                          | Wt. landed<br>in 100 cwt. | 100 hours<br>fishing | Wt. landed<br>per 100 hrs. | Wt. landed<br>in 100 cwt. | 100 hours<br>fishing | Wt. landed<br>per 100 hrs. |
| January to March.....    | 134                       | 1769                 | 8                          | 988                       | 2731                 | 36                         |
| April to June.....       | 64                        | 951                  | 7                          | 733                       | 2389                 | 31                         |
| July to September.....   | 198                       | 1241                 | 16                         | 925                       | 2860                 | 32                         |
| October to December..... | 156                       | 1296                 | 12                         | 1320                      | 2648                 | 50                         |
| Year.....                | 549                       | 5257                 | 10                         | 3966                      | 10628                | 37                         |

<sup>1)</sup> Includes landings from unknown rectangles.

R. ELLIS.

### Merlan (*Gadus merlangus* L.) de la Manche.

L'étude des merlans pêchés au chalut par le navire "Président Théodore Tissier" du 27 Janvier au 2 Février 1951 sur le banc du Vergoyer, a porté sur la répartition des tailles, la composition du stock au point de vue de l'âge, et la maturité sexuelle.

#### I. Répartition des tailles.

Origine: Banc du Vergoyer.

50°34' à 50°38' L.N.

1°11' à 1°18' E.G.

Sondes: 40 à 55 mètres.

Dates: 27/1/51 et 2/2/51; chalutage de jour.

Egin: chalut de 22 m. "Président Théodore Tissier".

Observateurs: DESBROSSES et FAURE.

Il résulte du tableau annexé que 78% des merlans pêchés mesurent 19 à 25 cm.; 21%: 26 à 37 cm.; 1% seulement mesure 38 à 51 cm.

| Taille<br>en cm. | ♂     | ♀     | total | %    |
|------------------|-------|-------|-------|------|
| 19               | 2     | 1     | 3     | 0.7  |
| 20               | 11    | 14    | 25    | 6.4  |
| 21               | 20    | 21    | 41    | 10.5 |
| 22               | 40    | 85    | 75    | 19.2 |
| 23               | 31    | 53    | 84    | 21.5 |
| 24               | 23    | 31    | 54    | 13.8 |
| 25               | 12    | 9     | 21    | 5.3  |
| 26               | 7     | 8     | 15    | 3.8  |
| 27               | 5     | 6     | 11    | 2.8  |
| 28               | 6     | 5     | 11    | 2.8  |
| 29               | 6     | 2     | 8     | 2    |
| 30               | 7     | 5     | 12    | 3    |
| 31               | 3     | 4     | 7     | 1.7  |
| 32               | —     | 2     | 2     | 0.5  |
| 33               | 4     | 2     | 6     | 1.5  |
| 34               | 1     | 1     | 2     | 0.5  |
| 35               | 1     | 3     | 4     | 1    |
| 36               | —     | —     | —     | —    |
| 37               | —     | 4     | 4     | 1    |
| 38               | —     | 1     | 1     | 0.2  |
| 39               | —     | —     | —     | —    |
| 40               | —     | 1     | 1     | 0.2  |
| 44               | —     | 1     | 1     | 0.2  |
| 45               | —     | —     | —     | —    |
| 46               | —     | 1     | 1     | 0.2  |
| 51               | —     | 1     | 1     | 0.2  |
| nombre           | 179   | 211   | 390   |      |
| modes, cm.       | 22-30 | 23-30 | 23-30 |      |



## II. Distribution par groupes d'âges.

| Groupe                 | I         | II      | III     | IV   |
|------------------------|-----------|---------|---------|------|
| Classe annuelle.....   | 1949      | 1948    | 1947    | 1946 |
| ♂                      |           |         |         |      |
| tailles extrêmes.....  | 19.5-25.5 | 21-33   | 27.5-35 | —    |
| (1 à 30.5 cm.)         |           |         |         |      |
| taille moyenne         |           |         |         |      |
| (mesurée au 1/2 cm.) . | 22.70     | 26.84   | 31.25   | —    |
| nombre.....            | 54        | 29      | 10      | —    |
| ♀                      |           |         |         |      |
| tailles extrêmes.....  | 20-34     | 23.5-37 | 30-46   | —    |
| taille moyenne         |           |         |         |      |
| (mesurée au 1/2 cm.) . | 23.45     | 28.67   | 36.93   | 51.5 |
| nombre.....            | 103       | 26      | 8       | 1    |
| ♂ + ♀: taille moyenne. | 23.19     | 27.70   | 33.77   | —    |

L'âge a été déterminé à la lecture des otolithes.

Les tailles prédominantes de 22 et 23 cm. correspondent aux tailles moyennes du groupe I, comprenant les merlans sur le point d'atteindre 2 ans, l'anneau d'hiver actuel n'étant pas encore apparent au bord de l'otolithe. Le mode moins important de 30 cm. est dû à l'interférence des groupes II et III.

D'après ce tableau, la croissance serait plus lente en Manche orientale qu'en Atlantique (DESBROSSES, 1948).

## III. Répartition et maturité sexuelles.

La taille maxima et la croissance annuelle sont inférieures chez les mâles, conformément aux observations antérieures.

La proportion des sexes est: 46% de mâles, 54% de femelles. Les femelles sont plus nombreuses que les mâles dans le groupe I et, au contraire, moins nombreuses dans les groupes II et III. Cette répartition des sexes est due à la croissance plus lente des mâles: aux mêmes tailles, les mâles sont généralement plus âgés que les femelles.

La ponte est commencée à la fin de Janvier, en Manche orientale: tous les merlans mesurant au moins 30 cm. sont adultes et aux stades V ou VI de HJORT. Les plus petits arrivés au stade VI mesurent 20.5 cm. dans les deux sexes. De 19 à 22 cm. 90% sont immatures (stades I—II de HJORT). A la taille de 25 cm. le nombre des immatures est égal à celui des matures. Les plus grands immatures mesurent 27.5 cm. pour les femelles (groupe I), 29.5 cm. pour les mâles. Il semblerait donc que la première maturité sexuelle se présentât à 2 et 3 ans en Manche orientale: à des tailles plus grandes et à un âge plus avancé qu'à la côte française de l'Atlantique (DESBROSSES, 1945). D'autres observa-

tions (en particulier sur la maturité sexuelle du groupe 0) sont nécessaires au cours de la longue période de ponte, pour élucider cette question.

P. DESBROSSES.

## Plaice.

## British Landings, 1950 and 1951.

The distribution of catches of plaice by British steam trawlers in 1950 and 1951 is shown in the charts in Figure 13, which give the catch in cwt. per 100 hours fishing for each statistical rectangle in the North Sea. A comparison with the charts for 1938 and 1946 (MARGETTS and HOLT, Rapp. et Proc.-Verb., CXXII, 1948, Fig. 12) and 1948 and 1949 (BEVERTON, Ann. Biol., VI, 1950, Fig. 17) suggests that the decline from the high densities existing immediately after the war has nearly ceased, and that the stock has reached an almost steady state. This effect is also shown in Table 13, in which the catch, in cwt. per 100 hours fishing, from two rectangles G4, (Smith's Knoll) and G7 (Silver Pits), for 1938 and 1946—51 is compared.

Table 13. Cwt/100 hours fishing from Smith's Knoll and Silver Pits.

|    | 1938 | 1946 | 1947 | 1948 | 1949 | 1950 | 1951 |
|----|------|------|------|------|------|------|------|
| G4 | 33   | 79   | 63.2 | 61.3 | 60.3 | 44.5 | 43.7 |
| G7 | 25   | 75   | 54.4 | 54.5 | 41.2 | 40.9 | 43.3 |

A levelling-off is also expected on theoretical grounds, as the fish which were of a catchable size during the war, and thus could benefit directly from the lack of fishing then, are now 9 years old and older, and these fish now form only a very small part of the present catches (see Table 15).

As in previous years, measurements were made of plaice in commercial landings at Lowestoft and Grimsby, and otoliths were taken for age determination of fish of each length-group. Table 14 shows the estimated total landings of plaice at each port for the biological years (April-March) 1950—51 and 1951—52, summarized in 5-cm. length-groups.

These length distributions have been converted into age-distributions by means of an age—length key obtained from otolith samples.

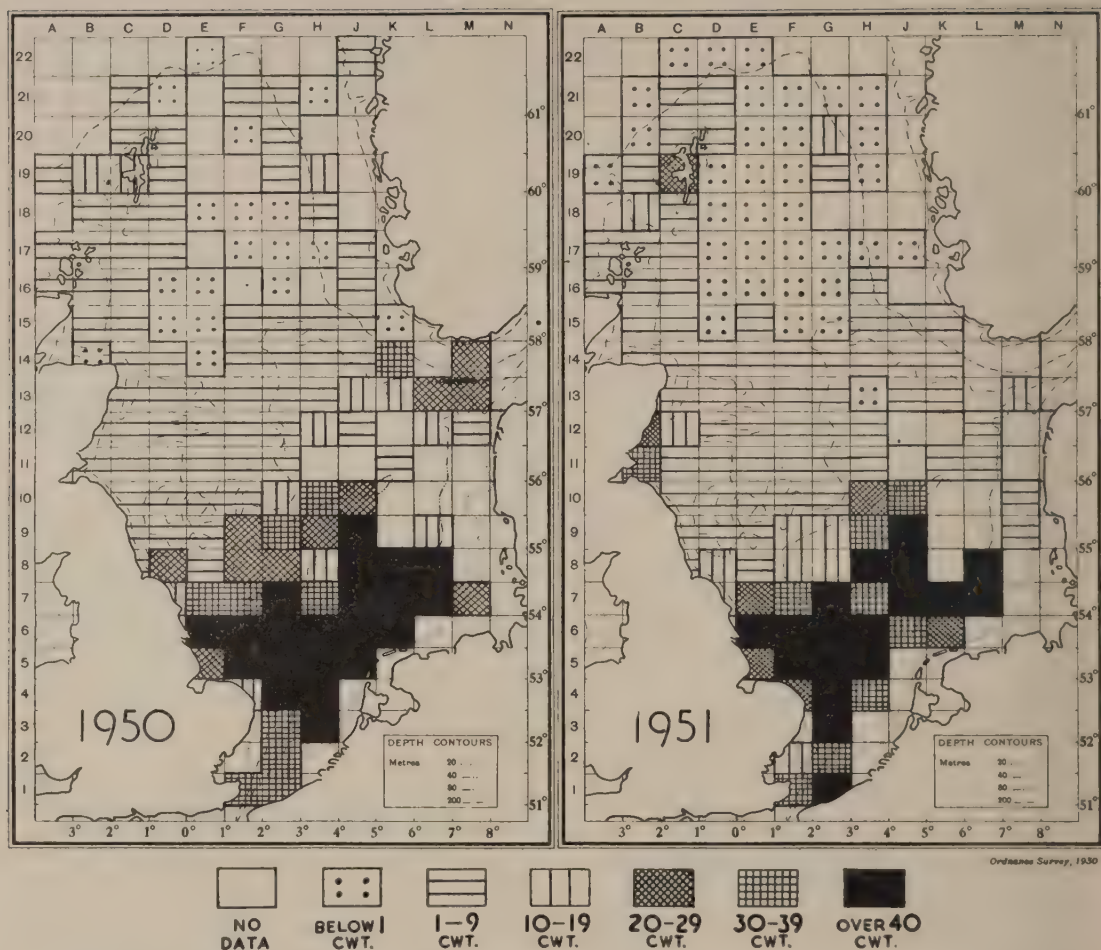


Figure 13. Average catch of plaice for 100 hours fishing by British 1st-class steam trawlers, 1950 and 1951.

Table 14. Length distributions of Lowestoft and Grimsby plaice landings. Thousands of fish.

| Length-Groups             | Lowestoft<br>1950—51 |       | Grimsby<br>1950—51 |       | Lowestoft<br>1951—52 |       | Grimsby<br>1951—52 |       |
|---------------------------|----------------------|-------|--------------------|-------|----------------------|-------|--------------------|-------|
|                           | Nos.                 | %     | Nos.               | %     | Nos.                 | %     | Nos.               | %     |
| 20—24.....                | 94                   | 0.5   | 44                 | 0.2   | 146                  | 0.7   | 39                 | 0.2   |
| 25—29.....                | 7,838                | 46.3  | 4,272              | 24.5  | 10,768               | 47.5  | 4,596              | 24.1  |
| 30—34.....                | 5,503                | 32.5  | 6,158              | 35.4  | 7,968                | 35.2  | 8,057              | 42.2  |
| 35—39.....                | 2,030                | 12.0  | 3,673              | 21.1  | 2,386                | 10.5  | 3,950              | 20.7  |
| 40—44.....                | 866                  | 5.1   | 1,668              | 9.6   | 823                  | 3.6   | 1,386              | 7.2   |
| 45—49.....                | 372                  | 2.2   | 863                | 5.0   | 373                  | 1.7   | 599                | 3.1   |
| 50—54.....                | 165                  | 1.0   | 485                | 2.8   | 140                  | 0.6   | 303                | 1.6   |
| 55—59.....                | 59                   | 0.3   | 184                | 1.1   | 46                   | 0.2   | 126                | 0.7   |
| 60+.....                  | 13                   | 0.1   | 51                 | 0.3   | 10                   | 0.0   | 37                 | 0.2   |
| Total.....                | 16,940               |       | 17,398             |       | 22,660               |       | 19,093             |       |
| 1000 hours Fishing.....   |                      | 281.5 |                    | 394.5 |                      | 325.6 |                    | 372.6 |
| Samples.....              | 270                  |       | 114                |       | 330                  |       | 150                |       |
| Landings (1000 cwt.)..... |                      | 102.4 |                    | 147.8 |                      | 125.3 |                    | 145.0 |

**Table 15. Number of fish of each age caught by Lowestoft trawlers per 100 hours fishing.**

| Age          | II | III   | IV    | V     | VI  | VII | VIII | IX | X  | XI | XII+ | Total |
|--------------|----|-------|-------|-------|-----|-----|------|----|----|----|------|-------|
| 1949—50..... | 59 | 1,322 | 3,793 | 1,135 | 365 | 143 | 124  | 71 | 86 | 63 | 90   | 7,251 |
| 1950—51..... | 39 | 929   | 2,320 | 1,722 | 389 | 198 | 93   | 95 | 81 | 57 | 94   | 6,017 |
| 1951—52..... | 91 | 559   | 2,576 | 2,055 | 982 | 261 | 152  | 71 | 57 | 60 | 87   | 6,960 |

The estimates obtained from Lowestoft samples, expressed as the number of fish of each age caught per 100 hours fishing, for the biological years 1949—51 are given in Table 15.

A statistical analysis is being made of these measurements. Preliminary results have shown that, for the length measurements, the important factor determining the sampling variation of the final estimates is the number of separate samples taken (i.e., the number of ships from which measurements were made), rather than the total number of fish measured. The coefficient of variation was greater for the larger fish than the smaller, and for Grimsby than Lowestoft, landings. For the number of samples actually taken it was 2—3 % for the 25—29-cm. group at Lowestoft and about 10 % for the larger Grimsby fish. It is hoped that these figures will be reduced in future by certain alterations in the sampling technique.

The variance of the age estimates depended more directly on the number of otoliths used; in 1951—52 1770 fish were otolithed, including 350 of each of the three smallest, and most abundant length groups. This gave a coefficient of about 5 % for the abundant IV- and V-group fish, rising to 10—15 % for the older fish.

J. A. GULLAND.

#### **Occurrence of 0-group Plaice in the Danish Waddensea.**

The abundance of 0-group plaice in the Danish Waddensea off south-west Jutland was studied by help of a chartered motorboat in late June, September and October 1951. The 0-group was very scarce, only about 4 specimens per hour as against an average of ca. 200 specimens per hour for 1935—1951.

The I-group and II-group were rather well represented early in the year, but very scarce in the autumn.

Å. VEDEL TÅNING.

#### **Marking Experiments in the Central North Sea Area.**

Since the war marking of medium and large plaice has been carried out in the Dogger bank area each spring. The recapture percentage has been increasing year after year until 1951, when the recaptures decreased to about half the preceding years' recaptures. Of 1150 specimens marked in the spring 1951 only 26.8 % were recaptured during the first half year (in 1946: 29.5, in 1947: 31.5, 1948: 36.6, 1949: 42.7 and 1950: 51.4 %). The causes of this decrease seem to be partly that many of the Danish seine cutters during summer and autumn were occupied by herring fishery, partly that fishing on Dogger bank was difficult in many areas owing to very rich growth of *Alcyonidium*.

Å. VEDEL TÅNING.

#### **The Stock of Plaice at Jutland and the Danish Plaice Fishery.**

##### **The Stock of Plaice at Jutland.**

Quantitative fishing was carried out from the research-cutter "Jens Væver" in June in the southern Horns Reef area at 4 stations between 5 and 9 m. depth, 7 stations between 10 and 19, 11 stations between 20 and 29, and 2 stations at 32 and 33 m. depth, and between Horns Reef and Thyborøn at 2 stations between 5 and 9 m. depth, 5 stations between 10 and 19 m. and 1 station at 22 m. depth. Outside the 30 m. depth curve the stock of plaice was very thin. In 22 m. depth north of the Horns Reef 64 plaice were found in 1 hour. The number of plaice caught per hour in the other depth-zones are shown in Table 16. It will be seen that in 1951 proportionally many more of the various length- and age-groups were found inside the 10 m. curve than in 1950 especially to the south of Horns Reef. Here the area of the depth zone 5—10 m. is about 1/10 of that of the 10—30 m. zone, and using this proportion-figure we can add the numbers in these zones giving due account



**Table 16. Numbers of Plaice caught per hour with the 50-foot ottertrawl off the west coast of Jutland in June 1951,**

**compared with mean for the years 1934-39 (June 1934-37, May-June and August 1938 and July 1939), and with June 1950.**

Length-groups between 5 and 35 cm.

| cm.                      | 5/9 | 10/14 | 15/19 | 20/24 | 25/29 | 30/34 | Total |
|--------------------------|-----|-------|-------|-------|-------|-------|-------|
| Southern Horns Reef area |     |       |       |       |       |       |       |
| 5-10 m., 1950:..         | 61  | 85    | 79    | 5     | —     | —     | 230   |
| 5-10 m., 1951:..         | 186 | 295   | 350   | 91    | 7     | —     | 929   |
| 10-30 m., 1934/39:       | 84  | 130   | 98    | 48    | 13    | 1     | 374   |
| 10-30 m., 1950:..        | 14  | 79    | 250   | 93    | 26    | 2     | 464   |
| 10-30 m., 1951:..        | 6   | 55    | 87    | 54    | 11    | 2     | 215   |

Between Horns Reef and Thyborøn

|                   |     |    |     |     |    |   |     |
|-------------------|-----|----|-----|-----|----|---|-----|
| 5-10 m., 1951:..  | 121 | 53 | 56  | 157 | 6  | — | 393 |
| 10-20 m., 1951:.. | 53  | 45 | 116 | 183 | 64 | 3 | 465 |

Age-groups I—VII+

|                          | I   | II  | III | IV  | V  | VI | VII+ |
|--------------------------|-----|-----|-----|-----|----|----|------|
| Southern Horns Reef area |     |     |     |     |    |    |      |
| 5-10 m., 1950:..         | 69  | 83  | 89  | 2   | —  | —  | —    |
| 5-10 m., 1951:..         | 216 | 419 | 135 | 168 | 6  | 1  | —    |
| 10-30 m., 1934/39:       | 132 | 150 | 53  | 14  | 10 | 15 | 2    |
| 10-30 m., 1950:..        | 25  | 109 | 284 | 45  | 2  | —  | —    |
| 10-30 m., 1951:..        | 11  | 79  | 56  | 62  | 7  | 1  | 1    |

Between Horns Reef and Thyborøn

|                   |     |     |     |     |    |   |   |
|-------------------|-----|-----|-----|-----|----|---|---|
| 5-10 m., 1951:..  | 160 | 60  | 27  | 42  | 6  | 1 | — |
| 10-20 m., 1951:.. | 77  | 103 | 128 | 145 | 11 | — | — |

for their sizes. The 1950 year-class was found to be rather abundant in depths of less than 10 m. but very poorly represented outside the 10 m. curve. In the Waddensea the 0-group of the 1950 year-class was found to be very much richer than normal (see TÅNING in Ann. Biol. VII, p. 92). The growth of this year-class must have been very much retarded by the density of the stock.

The strength of the 1949 and 1948 year-classes obviously was below the normal but the 1947 year-class was abundantly represented both to the north and south of the Horns Reef. Plaice of the older year-classes were few, also those of the very rich year-class 1946.

It is seen that from 1950 to 1951 there was a great decline in the number of the 1947 and 1946 year-classes, and a corresponding decrease in the number of the length-groups over 15 cm. Many of these year-classes had wandered to the open North Sea.

#### The Danish Plaice Fishery.

(Market investigations at Esbjerg carried out from Dr. TÅNINGS department).

#### Density of the Stock.

The mean weight per landing in tons of Danish cutters was as follows (number of landings in brackets, map of areas in Ann. Biol. IV, p. 101):—

|                         | 1948-49  | 1950    | 1951     |
|-------------------------|----------|---------|----------|
| C2, north-eastern, Oct. | —        | 4.4 (9) | 5.2 (10) |
| Dogger, March-Nov....   | 2.1 (22) | 3.0 (5) | 3.3 (9)  |

The stock had improved as compared with 1950, and the landings in the north-eastern part of C2 (depths more than 40 m., east of 5° E. Long. and north of 55° N. Lat.) in October were larger than in most of the previous years. This improvement must undoubtedly have been caused partly by the fact that the commercial stock was recruited from the rich year-classes 1946 and 1947, but a contributory cause must be found in the decline in the fishing intensity for plaice in these regions because many of the Danish cutters took part in the new herring fishery at the Clay Deep and to the North of the White Bank.

#### Length and Age Composition of the Catches.

The length composition off the Jutland coast in 10-20 m. depth was as normal; about 90 % of the plaice caught were 270-300 mm. long. To the north of the White Bank (C2, north-east, E. of 5°30' E. Long.), the average

**Table 17. Length Composition of Plaice (%) in Danish Catches in 1951, compared with 1950.**

| Area           | C2, NE. |      | Dogger Bank |      |      |
|----------------|---------|------|-------------|------|------|
|                | 1950    | 1951 | 1950        | 1951 | 1951 |
| Year           | X       | IX-X | V-X         | V-VI | IX-X |
| Month          | X       | IX-X | V-X         | V-VI | IX-X |
| Depth, m.      | 47      | 50   | 35          | 33   | 38   |
| No. of catches | 5       | 9    | 4           | 4    | 5    |
| cm.-group      |         |      |             |      |      |
| 27-30 ...      | 92      | 81   | 26          | 47   | 13   |
| 31-35 ...      | 7       | 16   | 35          | 32   | 37   |
| 36-40 ...      | 0.2     | 2    | 28          | 14   | 36   |
| 41-45 ...      | 0.03    | 0.5  | 8           | 4    | 9    |
| 46-50 ...      | 0.03    | 0.1  | 1           | 2    | 4    |
| 51-55 ...      | 0.01    | 0.02 | 1           | 0.6  | 0.5  |
| 56-60 ...      | —       | 0.01 | 0.5         | 0.4  | 0.6  |
| 61-65 ...      | —       | —    | 0.2         | 0.1  | 0.2  |

length of the commercial plaice had increased a little from October 1950 to September-October 1951. At the Dogger Bank it decreased from 1950 to May-June 1951. In October it had increased again (see Table 17), although the percentage of IV-group plaice had increased and the average age of the stock had thereby been diminished (see Table 18). The growth of the plaice seems to have been very fast.

**Table 18. Age Composition of Plaice (%) in Danish Catches.**

| Area<br>Year<br>Month<br>Depth, m.<br>Age-groups | SE. of Dogger |            | Dogger     |           | Year-class<br>in 1951 |
|--------------------------------------------------|---------------|------------|------------|-----------|-----------------------|
|                                                  | 1950<br>VIII  | 1951<br>IV | 1951<br>VI | 1951<br>X |                       |
|                                                  | 44            | 29—47      | 28         | 38        |                       |
| III                                              | 2             | 30         | —          | 3         | 1948                  |
| IV                                               | 48            | 54         | 28         | 43        | 1947                  |
| V                                                | 37            | 12         | 55         | 37        | 1946                  |
| VI                                               | 11            | 3          | 14         | 13        | 1945                  |
| VII+                                             | 2             | 1          | 3          | 4         | 1944—                 |

AAGE J. C. JENSEN.

### Scottish East Coast.

Immediately after the second world war the landings of plaice in Scotland by British vessels reached a higher level than at any time during the period between the two wars. In 1946 the highest total, of 114,414 cwts., was landed from the North Sea. Slightly more than half of this total was caught by seine-net and the rest by trawl. In 1947 the landings slumped to 79,709 cwts., mainly as a result of a marked decline in trawl-caught fish. A further decline in 1948, again mainly in trawl-caught plaice, was followed by a recovery in 1949, which was entirely due to an increase in the seine-net landings. In that year landings by seine attained a new high level of 68,296 cwts. A decline followed in 1950 and figures for 1951 are not yet available. Trawl landings appear to have become stabilised at about one sixth of the total; as negligible quantities are now landed by small lines the remaining five-sixths of the North Sea total are by seine.

Although the numbers of plaice caught by the research vessels on grounds outwith the recognised nursery grounds are small, age

**Table 19. Scottish East Coast 4—37 metres. March-May 1951 (F.R.V. "Kathleen").**

|                 | Size Composition (by 5-cm. groups) %. |       |       |       |       |       |       |     | Age Composition. Numbers per 4 hours fishing<br>4-37 metres. |           |            |             |            |           |            |             |              |       |
|-----------------|---------------------------------------|-------|-------|-------|-------|-------|-------|-----|--------------------------------------------------------------|-----------|------------|-------------|------------|-----------|------------|-------------|--------------|-------|
|                 | 10 cm.<br>and<br>under                | 11—15 | 16—20 | 21—25 | 26—30 | 31—35 | 36—40 | 41+ | Total<br>Caught                                              | I<br>1950 | II<br>1949 | III<br>1948 | IV<br>1947 | V<br>1946 | VI<br>1945 | VII<br>1944 | VIII<br>1943 | Total |
| Moray Firth     |                                       |       |       |       |       |       |       |     |                                                              |           |            |             |            |           |            |             |              |       |
| Dornoch Firth   | 18.3                                  | 34.2  | 27.9  | 14.3  | 4.9   | 0.4   | —     | —   | 1,762                                                        | 162       | 286        | 228         | 169        | 31        | 5          | 1           | —            | 882   |
| Nairn Bay       | 24.9                                  | 12.8  | 43.3  | 15.2  | 3.6   | 0.1   | —     | —   | 795                                                          | 203       | 105        | 119         | 292        | 39        | 31         | 4           | 2            | 795   |
| Burghead Bay    | 4.8                                   | 14.3  | 45.3  | 29.8  | 5.5   | 0.3   | —     | —   | 1,555                                                        | 74        | 221        | 781         | 457        | 22        | —          | —           | —            | 1,555 |
| Spey Bay        | 32.4                                  | 18.4  | 12.9  | 19.0  | 15.0  | 2.3   | —     | —   | 533                                                          | 178       | 135        | 138         | 75         | 7         | —          | —           | —            | 533   |
| Aberdour Bay    | 9.4                                   | 14.2  | 41.7  | 19.6  | 11.2  | 3.5   | 0.4   | —   | 520                                                          | 89        | 230        | 133         | 51         | 17        | —          | —           | —            | 520   |
| Aberdeen Bay    | 59.3                                  | 2.9   | 6.9   | 24.2  | 5.8   | 0.7   | 0.1   | 0.1 | 9,386                                                        | 704       | 53         | 397         | 8          | 10        | 1          | (VI-XV)     | —            | 1,173 |
| St. Andrews Bay | 13.0                                  | 37.8  | 22.9  | 24.1  | 0.2   | +     | —     | —   | 3,438                                                        | 377       | 1467       | 792         | 290        | 508       | 4          | —           | —            | 3,438 |
| Firth of Forth  |                                       |       |       |       |       |       |       |     |                                                              |           |            |             |            |           |            |             |              |       |
| Largo Bay       | 13.8                                  | 47.7  | 33.6  | 3.1   | 1.8   | —     | —     | —   | 319                                                          | 49        | 243        | 18          | 8          | 1         | —          | —           | —            | 319   |
| Aberlady Bay    | 33.2                                  | 39.3  | 19.8  | 5.5   | 1.8   | 0.3   | 0.1   | —   | 1,055                                                        | 660       | 335        | 44          | 10         | 6         | —          | —           | —            | 1,055 |

### Age Composition (%).

### Mean Sizes of Age-Groups (cm.).

|                 | I    | II   | III  | IV   | V    | VI           | VII | VIII | I    | II   | III  | IV   | V    | VI   | VIII | VIII | X-XV |
|-----------------|------|------|------|------|------|--------------|-----|------|------|------|------|------|------|------|------|------|------|
| Moray Firth     |      |      |      |      |      |              |     |      |      |      |      |      |      |      |      |      |      |
| Dornoch Firth   | 18.4 | 32.4 | 25.0 | 19.2 | 3.5  | 0.6          | 0.1 | —    | 8.2  | 13.3 | 17.9 | 21.8 | 26.2 | 27.9 | 32.5 | —    | —    |
| Nairn Bay       | 25.5 | 13.2 | 15.0 | 36.7 | 4.9  | 3.9          | 0.5 | 0.3  | 8.3  | 15.0 | 17.0 | 19.3 | 22.4 | 25.5 | 29.8 | 28.0 | —    |
| Burghead Bay    | 4.8  | 14.2 | 50.2 | 29.4 | 1.4  | —            | —   | —    | 8.0  | 13.9 | 19.1 | 22.8 | 27.5 | —    | —    | —    | —    |
| Spey Bay        | 33.4 | 25.3 | 25.9 | 14.1 | 1.3  | —            | —   | —    | 8.0  | 15.5 | 23.3 | 26.3 | 29.4 | —    | —    | —    | —    |
| Aberdour Bay    | 17.1 | 44.2 | 25.6 | 9.8  | 3.3  | —            | —   | —    | 10.6 | 18.4 | 22.4 | 24.4 | 29.1 | —    | —    | —    | —    |
| Aberdeen Bay    | 60.0 | 4.5  | 33.9 | 0.7  | 0.8  | (0.1% VI-XV) |     |      | 8.5  | 15.9 | 23.5 | 27.4 | 29.7 | 39.3 | —    | 46.0 | 55.0 |
| St. Andrews Bay | 11.0 | 42.7 | 23.0 | 8.4  | 14.8 | 0.1          | —   | —    | 7.9  | 12.8 | 19.6 | 20.8 | 23.2 | 25.5 | —    | —    | —    |
| Firth of Forth  |      |      |      |      |      |              |     |      |      |      |      |      |      |      |      |      |      |
| Largo Bay       | 15.4 | 76.2 | 5.6  | 2.5  | 0.3  | —            | —   | —    | 8.6  | 14.9 | 21.9 | 22.1 | 23.0 | —    | —    | —    | —    |
| Aberlady Bay    | 62.6 | 31.7 | 4.2  | 0.9  | 0.6  | —            | —   | —    | 10.3 | 16.9 | 21.8 | 28.0 | 28.3 | —    | —    | —    | —    |

analysis from otoliths indicates that the stocks comprise fish of age-groups I to XIV, although most of the fish belong to groups III, IV and V. The majority of these young fish had not spawned, thus showing that a very large proportion of the commercial catch must consist of immature fish.

Investigations on the nursery grounds of the Scottish east coast were continued in 1951. Records obtained from March to May have been analysed and incorporated in the accompanying table, which is comparable with Table 6 in *Annales Biologiques*, N.N. Sea, Vol. VII (1950). Most of the observations recorded on last year's results will again be apparent in the table for the current year. Although the question of the variability in hauls on the same grounds is receiving special consideration, it seems likely that the different broods exhibit significant fluctuations from year to year and from place to place along the coast in the same year. There seems little doubt that this tends to minimise the extent of fluctuations in brood strength observed on offshore grounds. The different rates of growth in the bays also contribute towards this end. Plaice depart from bays in which growth is rapid anything up to two years or more earlier than from bays where growth is slow. This is exemplified by the successful 1948 brood in Aberdeen Bay, which by the end of 1951 was much reduced in numbers compared with 1950, and by the successful 1946 brood in St. Andrew's Bay which, as group V, was still present in appreciable numbers in 1951.

B. B. RAE. J. M. LAMONT.

## Dab.

### The Stock in the Southern Horns Reef Area.

From the number of dabs caught at the quantitative fishing from "Jens Væver" shown in Table 20 it is seen that the density and length distribution were very nearly the same in 1950 and 1951.

**Table 20. Average Number of Dab caught per hour in the southern Horns Reef Area in 10—30 m. Depth.**

| 1934—  | Length-group, cm. |       |       |       |       |       | Total |
|--------|-------------------|-------|-------|-------|-------|-------|-------|
|        | 5—9               | 10—14 | 15—19 | 20—24 | 25—29 | 30—34 |       |
| 38..   | 467               | 246   | 99    | 16    | 1     | —     | 809   |
| 1950.. | 52                | 237   | 180   | 43    | 5     | 0.1   | 517   |
| 1951.. | 44                | 218   | 191   | 29    | 3     | 0.1   | 474   |

Proportionally few dabs of 5—9 cm. length have been caught in 1950—51, because of the larger meshes used in the extra-fine-meshed cod-end during these years; they were of twine 12/15, 20 mm. from knot to knot, which corresponds to about 26 mm. measured wet with a 2 mm. thick gauge. These meshes allow half of the number of dab of ca. 8 cm. length to escape. In the previous years the meshes in the fine-meshed cod-end were ca. 6 mm. from knot to knot.

The table shows that the number of dabs above 15 cm. in length was twice as large as the mean for 1934—38, but it must be mentioned that in 1934 and 1938 it was of about the same size as in 1950—51.

AAGE J. C. JENSEN.

## Mackerel.

### Tagging Experiments on Mackerel in Norwegian Waters.

In connection with the routine investigations on mackerel it was found of importance to carry out some tagging experiments. Such experiments have previously been carried out in U. S. A.<sup>1)</sup>

The mackerels used for our experiments were always caught by a seine (land-seine), and, therefore, the fish had not suffered any injuries when caught. From the seine the fish were transferred to a "bag", a live-net, kept floating on the sea by ordinary corks. When tagging, the fish were taken up by a catcher. After tagging, they were kept in another live-net, and liberated in the evening as a little shoal.

Several types of tags have been used:

1) Celluloid discs with a diameter of 12 mm., fixed by nylon in the back between the dorsal fins. 2) The hydrostatic tags constructed by EINAR LEA. These tags were fixed dorsally by a wire of stainless steel. 3) A cylinder of Al-cathene film, introduced by OLAV AASEN. Also these tags were fixed dorsally by a wire of stainless steel, or by nylon.

Before starting the real tagging experiments, we undertook some investigations in order to

<sup>1)</sup> DONALD H. FRY jr. and PHIL M. ROEDEL 1949: Tagging Experiments on the Pacific Mackerel (*Pneumatophorus diego*); OSCAR ELTON SETTE: Biology of the Atlantic Mackerel (*Scomber scombrus*) of the North America; Part II—Migrations and Habits.



see if the handling which the fish have to suffer during the tagging process, might cause any mortality.

From a catch of mackerel of the I-group, 500 specimens were kept in a live-net for control. In another live-net were kept: —1) 111 specimens to which had been fixed loops of wire (stainless steel), 2) 111 specimens with loops of nylon, and 3) 111 specimens which had been handled in the same way as the other groups, but without the loops of wire or nylon.

The fish were observed for 8 days. During that period 3 specimens of group 1) died. The



Figure 14. Tagging experiments on mackerel near Bergen ultimo 1951. Some recaptures from more distant localities.

reason was that the loop of wire had caught the meshes of the live-net in which the mackerels were kept. The mortality, therefore, was not related to the handling which the fish had suffered.

During the month of August 1950, 559 specimens of the I-group were tagged in one of the fjords a little south of Bergen.

A total of 280 individuals, or about 50%, have been recaptured, most of them shortly after tagging. Not a single specimen has been taken after 11. December 1950. The reason why is not clear.

During the summer 1951 we tagged 2038 specimens, 1738 mature mackerel and 300 of the I-group, in three different localities in West Norway. A total of 413 have hitherto been recaptured. The last one was found in a catch of herring taken on 26. January 1952 during the Norwegian winter-herring fishery.

The percentage of recaptures has been rather high, but these results will not be discussed in more detail before further experiments have been carried out. More material is also necessary for a discussion of the various methods.

Most of the recaptures have taken place shortly after tagging, and not very far from the tagging localities. An experiment carried out ultimo May 1951 northwest of Bergen, however, showed a number of recaptures from distant localities, see Fig. 13. One specimen was taken in a herring-trawl on the Fladen Ground 56 days after liberation. From the same experiment we also got recaptures from the eastern part of the Skagerak and Kattegat in the period 26. June to 3. December 1951. One specimen was recaptured in the Baltic, at Kap Arkona, Rügen, 9. August 1951.

In the study of the biology of the mackerel it seems that tagging experiments may give valuable information, for instance as to migrations, and therefore such experiments will be continued during the coming mackerel season.

ARNE REVHEIM.

### Rare Fishes.

Records of rare and exotic fishes from Scottish fisheries were both numerous and interesting in 1951. The main features of the records were

1. the remarkable number of specimens, including several extremely rare species, obtained in July and August;
2. the relatively large number of sturgeons caught during the year, including three from the Firth of Clyde;
3. the four records of electric rays, all from the west coast and including two from the Firth of Clyde;
4. the greater-than-average number of Ray's bream and the evidence of the presence of this species in considerable numbers on or near the Atlantic shelf.

The following is a list of the records, fuller details of which will be given in a paper to be published in the near future.

*Acipenser sturio* L.—sturgeon—7; 4 N. Sea, I, V, VI, X, 3 Firth of Clyde, VII, VIII, IX.

*Alosa alosa* (L.)—allis shad—2; Loch Fyne, Firth of Clyde, XI, XII.

*Alosa finta* (CUVIER)—twaite shad—1; off Eyemouth, II.

*Argentina silus* (ASCANIUS)—great silver smelt—2;  $1\frac{1}{2}$  cwt. Viking Bank, IV, 3 specimens NW. from Shetland, VI.

*Arnoglossus laterna* (WALBAUM)—scald fish—1; Nairn Bay, Moray Firth, X.

*Belone belone* (L.)—garfish—3; 1 Shetland, II, 1 off Aberdeenshire coast, X, 5 specimens Firth of Clyde, XI.

*Brama raii* (BLOCH)—Ray's breem—9; 4 records west coast from W. of Ireland to NW. of Butt of Lewis, totalling  $15\frac{1}{2}$  cwt. of fish, IX, X, 1 NW. of Orkney, X, 1 NW. of Shetland, XI, 2 SE. of Aberdeen, XI and XII, one 135' NE.  $\times$  E  $1\frac{1}{2}$  E. from Aberdeen, XII.

*Engraulis encrasicolus* (L.)—anchovy—1; 57°58'N. 0°03'E., II.

*Fierasfer dentatus* CUVIER—pearl fish—3; 2 N. Sea, II, 1 west coast, V.

*Labrus mixtus* L.—cuckoo wrasse—4; Outer Moray Firth, V and VIII (3).

*Mola mola* (L.)—sunfish—1; Rockall Bank, VIII.

*Mugil chelo* CUVIER—grey mullet—1; baby fish 3.3 cm. Loch Fyne, XI.

*Mullus surmuletus* L.—red mullet—1; Shetland, VIII.

*Naucrates ductor* (L.)—pilot fish—1; North Minch, VIII.

*Raniceps raninus* (L.)—lesser fork beard—2; 1 Aberdeen Bay, IV, 1 ESE. from Aberdeen, VI.

*Sarda sarda* (BLOCH)—belted bonito—1; Firth of Forth, VII.

*Sardina pilchardus* (WALBAUM)—pilchard—2; 2 specimens Minch, IX, 6 stones of fish in Firth of Forth, XII.

*Sciaena aquila* RISSO—meagre—1; off Aberdeenshire coast, VIII.

*Scomberesox saurus* (WALBAUM)—saury pike—2; 1 Minch, IX, 1 Firth of Forth, X.

*Torpedo nobiliana* BONAPARTE—electric ray—4; 2 Skerryvore and Dubh Artach, VIII, 2 Firth of Clyde, VIII and IX.

*Trigla lyra* L.—the piper—1; Lunna Firth, Shetland, VI.

Three rare specimens taken at Faroe or Iceland have been included in a report on the NW. Area.

B. B. RAE. E. WILSON.

# Transition Area.<sup>1)</sup>

## INTRODUCTION

Contributions have been received from Denmark (AAGE J. C. JENSEN, J. BOHUS JENSEN, J. B. KIRKEGAARD, J. KNUDSEN, ERIK M. POULSEN and HELGE THOMSEN) and Norway (ALF DANNEVIG, GUNNAR DANNEVIG, and JOHAN T. RUUD).

### A. Environment.

**Hydrography.** The year 1951 was conspicuous for the high salinity in late winter and again in late autumn.

**Benthic Food.** In the Limfjord the amount was, as has been the case for a series of years, below the normal, except in the Nisum Broad where it was a little above normal. The amount of non-food animals (*Mytilus* and *Ascidella*) had diminished considerably.

### B. Fish.

**Eggs and Larvae.** The number of cod larvae in Danish waters was far below the normal. The number of plaice larvae was small only. In the southern part of the area the number of flounder larvae was above the normal.

**Gadidae.** The 0-group of the cod was poor as well both along the Norwegian Skagerak coast as in the Danish waters; this was in good accordance with the small number of larvae

caught in spring. The number of whiting was on the whole smaller than in previous years.

**Plaice.** The number of 0-group was somewhat above normal in the northern part of the area, but below normal in the southern part. In the northern Kattegat a very rich I-group was present.

In the western Limfjord the number of plaice of the two youngest year-classes was normal or a little above normal and far bigger than in recent years.

The transplantations were continued both to the inner Limfjord and to the Belt Sea and adjacent waters, to the latter area on a somewhat smaller scale than in 1950.

An experimental transplantation was carried out from the Limfjord to the Oslo Fjord.

**Sprat.** An investigation of the abundance of the larvae in the Skagerak showed that the larvae occur in the coastal waters but not in the central part of the sea.

### Fish for Processing.

The Danish fishery for fish for processing is still increasing, amounting to ca. 110,000 tons in 1951. The considerable rise is partly due to the commencement of a new fishery for herring for processing in the central North Sea.

ERIK M. POULSEN.

<sup>1)</sup> A map showing the limits between the different sub-areas is given in Vol. V, p. 116.



## ENVIRONMENT

## Hydrography.

## 1. Danish Waters (Tables 1 and 2).

Unusually high salinities occurred in the bottom layer of the southern part of the Transition Area in January, February, March and in October, November, December. At Gedser Rev Lightvessel the bottom salinity was above normal throughout the year. In the period February to August the departures of the monthly means from the normal salinity ranged from 4.9 ‰ to 7.6 ‰, and in September, October, November and December the deviations were as high as between 9.4 ‰ and 9.9 ‰, which is exceptional.

In December also the surface salinities were very high in the Transition Area.

It is remarkable that although abnormal high salinity occurred in the southern part of the Transition Area the salinities at Skagens Rev Lightvessel in the northern part of the area were normal. The mean deviations of the surface salinities calculated for the year were  $-0.1$  ‰ for the surface and  $0.0$  ‰ for the bottom (38 m.).

An inspection of the current data from Halskov Rev (Table 2) shows that the excess of outflow over inflow from the Baltic was considerably less than normal, averaging only 2.5 cm./sec. for the year compared with the normal average of 11.1 cm./sec. The explanation of the high salinities in the southern part of the Transition Area seems therefore to be

**Table 1. Monthly Means of Salinity and Temperature at Surface and Bottom at the Lightvessels "Anholt Nord" (A) and "Halskov Rev" (H) for a Series of Years, and Deviations from these Means.**

(From the Danish Meteorological Institute, Nautical Department.)

| Month:             | I    | II   | III  | IV   | V    | VI             | VII  | VIII | IX   | X    | XI   | XII  |
|--------------------|------|------|------|------|------|----------------|------|------|------|------|------|------|
| <b>Salinity</b>    |      |      |      |      |      |                |      |      |      |      |      |      |
|                    |      |      |      |      |      | <b>Surface</b> |      |      |      |      |      |      |
| A Mean ...         | 23.5 | 23.1 | 20.2 | 19.2 | 18.1 | 18.9           | 19.4 | 20.1 | 20.7 | 20.7 | 21.9 | 22.8 |
| H Mean ...         | 16.8 | 14.8 | 13.4 | 13.9 | 13.0 | 14.3           | 13.9 | 14.4 | 14.6 | 16.2 | 16.3 | 15.6 |
| A 1951....         | -2.6 | -2.9 | 1.5  | 4.7  | 1.1  | -0.2           | 2.1  | 0.1  | -0.7 | -1.5 | 1.0  | 8.3  |
| H 1951....         | -0.6 | -1.0 | 4.6  | 3.0  | -1.0 | -0.9           | 2.1  | -1.3 | 0.1  | -3.7 | 0.5  | 9.4  |
|                    |      |      |      |      |      | <b>Bottom</b>  |      |      |      |      |      |      |
| A Mean ...         | 31.8 | 32.0 | 32.5 | 33.0 | 33.1 | 32.8           | 32.3 | 31.9 | 31.8 | 32.2 | 32.4 | 32.1 |
| H Mean ...         | 21.9 | 21.7 | 24.5 | 27.6 | 29.7 | 30.3           | 29.4 | 27.6 | 24.7 | 23.3 | 21.5 | 22.1 |
| A 1951....         | 2.0  | 1.9  | 1.5  | 0.8  | 0.8  | 1.4            | 1.0  | 0.7  | 1.1  | 1.3  | 1.4  | -0.1 |
| H 1951....         | 5.2  | 8.4  | 5.0  | 1.4  | -2.5 | -0.8           | 0.6  | 0.2  | 4.1  | 6.7  | 7.5  | 4.2  |
| <b>Temperature</b> |      |      |      |      |      |                |      |      |      |      |      |      |
|                    |      |      |      |      |      | <b>Surface</b> |      |      |      |      |      |      |
| A Mean ....        | 2.2  | 1.4  | 1.9  | 4.5  | 9.4  | 14.2           | 16.8 | 16.7 | 14.5 | 10.9 | 7.1  | 4.1  |
| H Mean ....        | 2.4  | 2.0  | 2.4  | 4.5  | 8.9  | 12.7           | 15.7 | 16.4 | 14.5 | 11.1 | 7.3  | 4.0  |
| A 1951....         | -0.1 | 0.0  | -0.8 | -0.3 | 0.6  | 0.5            | -0.2 | 0.7  | 1.6  | 1.7  | 2.4  | 2.7  |
| H 1951....         | -0.5 | -0.8 | -0.9 | 0.3  | -0.1 | 2.2            | 0.4  | 0.6  | 1.4  | 0.8  | 1.5  | 2.3  |
|                    |      |      |      |      |      | <b>Bottom</b>  |      |      |      |      |      |      |
| A Mean ....        | 6.1  | 4.7  | 4.3  | 4.3  | 4.9  | 6.7            | 9.7  | 12.7 | 13.1 | 12.1 | 10.2 | 8.1  |
| H Mean ....        | 3.9  | 3.4  | 3.4  | 4.3  | 5.7  | 7.1            | 9.1  | 11.7 | 13.2 | 11.6 | 8.4  | 5.9  |
| A 1951....         | 1.3  | 0.7  | 0.5  | -0.1 | -0.5 | -1.4           | -3.1 | -1.5 | 0.9  | 1.1  | 0.9  | -1.1 |
| H 1951....         | 1.3  | 2.0  | 1.1  | 0.1  | 0.6  | 0.1            | -0.5 | -0.5 | -1.0 | 1.4  | 3.0  | 0.5  |

**Table 2. Monthly Means of Residual Surface Currents in cm. sec. at the Lightvessel "Halskov Rev". The Current from the Baltic is stated as positive, towards the Baltic as negative.**

(From the Danish Meteorological Institute, Nautical Department.)

|            | I   | II  | III  | IV   | V    | VI  | VII  | VIII | IX   | X    | XI    | XII  |
|------------|-----|-----|------|------|------|-----|------|------|------|------|-------|------|
| 1951 ..... | 7.7 | 8.0 | -8.7 | 11.0 | 25.3 | 7.7 | -6.0 | 19.1 | -6.9 | 10.8 | -30.1 | -7.7 |

that the "front" of the Baltic water has receded from its normal position.

High temperature anomalies occurred in the autumn.

HELGE THOMSEN.

## 2. Norway. Coast of Skagerak.

The sea temperature near Arendal at a depth of one metre was very low during

| Average    | Jan. | Feb. | March | April | May  | June  | July  | Aug.  | Sept. | Oct.  | Nov. | Dec. |
|------------|------|------|-------|-------|------|-------|-------|-------|-------|-------|------|------|
| 1919—29 .. | 3.06 | 1.60 | 2.33  | 4.63  | 8.80 | 12.28 | 15.52 | 15.63 | 13.94 | 10.84 | 7.14 | 4.70 |
| 1930—39 .. | 3.41 | 2.73 | 2.34  | 4.79  | 9.39 | 13.34 | 16.61 | 17.37 | 14.95 | 11.45 | 8.09 | 5.22 |
| 1940—49 .. | 2.69 | 1.67 | 1.87  | 4.36  | 9.46 | 13.38 | 16.84 | 16.99 | 15.04 | 11.73 | 8.11 | 5.86 |
| 1950.....  | 3.6  | 2.2  | 3.2   | 5.8   | 10.8 | 13.0  | 16.1  | 17.5  | 15.1  | 12.2  | 7.6  | 4.6  |
| 1951.....  | 1.3  | 1.1  | 1.0   | 3.6   | 8.8  | 13.5  | 15.0  | 16.1  | 15.1  | 12.6  | 8.5  | 7.4  |

ALF DANNEVIG.

## Benthic Food.

### 1. The Limfjord.

As in previous years surveys with the 0.1 m.<sup>2</sup> Petersen grab were carried out in the spring and the autumn in the different parts of the Limfjord.

The figures show the amount of bottom animals in g./m.<sup>2</sup> in the autumn of 1950 and the spring of 1951 in the two largest broads, Livø Broad and Nissum Broad (for explanation of the terms 1st-class food etc. *vide* Ann. Biol. III, p. 86).

|               | Livø Broad |           |          | Nissum Broad |           |          |
|---------------|------------|-----------|----------|--------------|-----------|----------|
|               | 1st class  | 2nd class | non-food | 1st class    | 2nd class | non-food |
| A 1950.....   | 11.3       | 13.3      | 118      | 15.1         | 109       | 122      |
| S 1951.....   | 5.0        | 3.7       | 475      | 7.1          | 171       | 7.3      |
| Mean.....     | 8.2        | 8.5       | 297      | 11.1         | 140       | 65       |
| Mean 1926—46. | 20         | 22        | 260      | 9.4          | 119       | 79       |

It appears that in the Livø Broad the amount of 1st-class plaice food is very low as it has now been for a number of years. This is also the case for 2nd-class plaice food. The group, non-food, consisting mainly of *Mytilus edulis* and *Ascidia aspersa* — is only a little above normal. This is in contrast to the conditions experienced for a number of recent years, when this group has been considerably above normal. As compared to the investigations in the autumn of 1949 and spring 1950 there is a minor decline in the amount of 1st-class food, a more conspicuous decline in the 2nd-

January-May 1951, but higher than normal in the autumn. Instead of giving the mean temperature for the whole period the decadic means are given. It will be noted that the summer and autumn temperatures are relatively high in the last decade 1940—49.

class group while there is a heavy decrease in the non-food group.

In Nissum Broad the amount of 1st-class food was a little above normal and the same was found to be the case in the group 2nd-class food, while the group non-food was slightly below normal. Compared with the investigations in autumn 1949 and spring 1950 the 1st-class food has increased somewhat, while a considerable increase was found in the 2nd-class food. In the group non-food an extremely heavy decline was found.

### 2. Other Danish Waters.

In several parts of the Transition Area smaller numbers of 0.1 m.<sup>2</sup> samples were procured by means of the Petersen grab. The amount of 1st-class food was as follows:—

|                          | C. Kattegat | N. Belts | Isefjord | S. Belts |
|--------------------------|-------------|----------|----------|----------|
| No. samples.....         | 10          | 15       | 25       | 20       |
| 1st-class food           |             |          |          |          |
| g./m. <sup>2</sup> ..... | 4.1         | 8.7      | 24.3     | 21.8     |

It appears that compared to the previous years (see Ann. Biol. VII, p. 101) there has been a decline in the amount of 1st-class food in the central Kattegat and northern Belts, while an increase was found particularly in the Isefjord and to some extent also in the southern Belts.

J. KNUDSEN.





The number of sprat larvae found in the vertical hauls is shown in the figure. If two observations have been made, the second one is given in brackets. — No sprat larvae were found in the central parts of the Skagerak. They were, however, very abundant in the Kattegat, where an intense spawning takes place. Spawning sprat were caught here in great quantities by commercial trawlers. Sprat larvae were also found off the coast of Sweden. Intense spawning had also taken place in Norwegian coastal waters, especially in the outer parts of the Oslofjord, and westwards towards Kragerø. In these waters a great number of newly hatched sprat larvae was found. They also occurred outside Arendal and Kristiansand, but here more scarcely.

GUNNAR DANNEVIG.

## Gadidae.

## 1. Danish Waters.

## Cod.

Fishing experiments were carried out from February to October with the eel-tog (a little small-meshed seine). As in recent years this small gear yielded only rather small catches owing to the diminishing stock of fishes in the inner Danish waters. In 1951 a larger gear, the cod-trawl has been used as well as the eel-tog.

It is seen from Table 3, giving the catches in 1951 in eel-tog compared with those from 1930—39, that the 0-group was poor in all waters, which is in good accordance with the very small catches of cod larvae in ring-trawls in the spring of 1951. Of the I- and II-group the Sound and the Belts yielded a catch near the normal or above the normal. The older year-classes were poorly represented except in the Sound, where the catch was near the normal or above the normal. This must be

attributed to the fact that trawling and seining are prohibited in the Sound.

As in 1950 comparative hauls were made in areas where trawling and seining are prohibited and in neighbouring areas where such fishing is allowed. Also this year the hauls in the area of protection yielded a far bigger catch (4 times as much) than in areas with no protection.

ERIK M. POULSEN.

## Whiting.

The number of whiting caught per 1 hour haul with the eel-tog was very much smaller than the numbers caught in the previous year as will appear from the following figures:

|                    | 1951      | 1950     | 1927—39 |
|--------------------|-----------|----------|---------|
| Kattegat, Sound... | 5.5 (13)  | 146 (50) | 42      |
| Belt Sea.....      | 26.1 (25) | 32 (91)  | 12      |

It is seen that the quantity of whiting was particularly low in the Kattegat and the Sound where the quantity obtained was also very much below the average value 1927—39. In the Belt Sea the quantity obtained was a little below the result of the previous year but still exceeding the average value 1927—39. However, too much attention should not be paid to these results, since the number of hauls is rather small.

The trawl, being a considerably more effective gear, yielded larger quantities of whiting. The number per 1 hour haul will appear from the following table:

|                         | Number<br>of Stations | Number<br>per 1 hour |
|-------------------------|-----------------------|----------------------|
| Skagerak .....          | 3                     | 1.3                  |
| N. Kattegat.....        | 14                    | 58                   |
| C. Kattegat.....        | 4                     | 0                    |
| S. Kattegat, Sound..... | 21                    | 63                   |
| Belts.....              | 55                    | 51                   |
| W. Baltic.....          | 9                     | 5.5                  |

J. KNUDSEN.

Table 3. Number of Cod caught per 1 hour in the Eel-Tog.

The figures in brackets state, for the corresponding age-groups, the means for the 10-year period 1930—39. For the 0-group (year-class 1951) only catches made after 1. June are considered.

|                  | No. of Stations |               | All<br>Year-<br>classes | Year-class |         |           |           |           |
|------------------|-----------------|---------------|-------------------------|------------|---------|-----------|-----------|-----------|
|                  | Febr.-<br>Oct.  | June-<br>Oct. |                         | 1951       | 1950    | 1949      | 1948      | older     |
| Skagerak.....    | 0               | 0             | — (2.1)                 | — (0.6)    | — (1.1) | — (0.4)   | — (0.1)   | — (0.1)   |
| N. Kattegat..... | 1               | 1             | 0 (7.4)                 | 0 (1.8)    | 0 (4.6) | 0 (2.8)   | 0 (1.2)   | 0 (0.1)   |
| C. Kattegat..... | 3               | 3             | 0 (45)                  | 0 (47)     | 0 (4.0) | 0 (2.0)   | 0 (0.8)   | 0 (0.2)   |
| S. Kattegat..... | 3               | 0             | 13 (32)                 | — (16)     | 11 (15) | 0.7 (3.2) | 0 (2.4)   | 0.7 (1.0) |
| Sound.....       | 5               | 2             | 90 (69)                 | 1.0 (13)   | 12 (24) | 64 (24)   | 10 (9.0)  | 2.0 (4.0) |
| Belts.....       | 26              | 12            | 37 (38)                 | 19 (32)    | 17 (12) | 4 (4.6)   | 1.5 (3.0) | 0 (1.0)   |
| W. Baltic.....   | 0               | 0             | — (25)                  | — (2.4)    | — (16)  | — (4.0)   | — (2.6)   | — (1.0)   |

## 2. Norwegian Waters.

### Young Fish.

The ordinary experimental fishing in the littoral region in September and October gave the following average numbers per haul:

**Table 4. Experimental Fishing, Average Number per Haul.**

|                            | Cod   |                     | Whiting | Pollack |
|----------------------------|-------|---------------------|---------|---------|
|                            | 0-Gr. | I-Gr. <sup>1)</sup> | 0-Gr.   | 0-Gr.   |
| Skagerak Coast<br>74 hauls |       |                     |         |         |
| Average 1917—29....        | 19.6  | 2.2                 | 15.2    | 22.7    |
| 1930—39....                | 7.2   | 1.1                 | 16.4    | 8.2     |
| 1940—49 <sup>2)</sup> ..   | 4.6   | 1.0                 | 29.0    | 8.7     |
| 1950.....                  | 4.2   | 0.9                 | 19.1    | 3.0     |
| 1951.....                  | 2.0   | 1.2                 | 18.2    | 2.6     |
| Oslofjord<br>57 hauls      |       |                     |         |         |
| Average 1936—39....        | 34.6  | 2.7                 | 8.3     | 6.8     |
| 1940—49 <sup>2)</sup> ..   | 20.9  | 2.6                 | 24.7    | 4.2     |
| 1950.....                  | 7.7   | 1.7                 | 9.5     | 1.8     |
| 1951.....                  | 2.3   | 0.8                 | 4.1     | 1.8     |

<sup>1)</sup> A few older specimens may be included.

<sup>2)</sup> The series are incomplete during the war. The few hauls made in 1940—44 are not included.

### Cod.

The 0-group cod was scarce both in the Oslofjord and along the Norwegian Skagerak coast. The occurrence of whiting was normal along the Skagerak coast but extremely low in the Oslofjord. The number of 0-group pollack was far below normal.

Experimental fishing with cod traps at Flødevigen resulted in 86.5 cod per trap, mostly the 1949 and 1950 year-classes.

|                |        |        |        |      |      |
|----------------|--------|--------|--------|------|------|
| Average.....   | 1921/9 | 1930/9 | 1940/9 | 1950 | 1951 |
| Cod per trap.. | 70     | 63     | 91     | 101  | 87   |

ALF DANNEVIG.

### Plaice, Flounder, and Turbot.

#### 1. Coastal Investigations. 0- and I-Groups.

The numbers of 0- and I-group plaice and of 0-group flounder caught with a Johansen young-plaice-trawl in 1—2 m. depth July-Sept. 1951 are given in Table 5. The number of 0-group plaice was normal in the Skagerak, twice the normal in the northern Kattegat, normal in the central Kattegat and below the normal in the southern Kattegat, the Sound, the Belts and the western Baltic. The sparseness of the 0-group in the southern Kattegat

and Belt Sea corresponds to the low surface temperatures and the unusually high bottom salinities stated for months Jan.-March 1951 (see Hydrography, p. 118).

**Table 5. Number of Plaice and Flounder caught per 1 hour on the Danish Coasts.**

|                  | Number of<br>Stations | Plaice   |          | Flounder |         |
|------------------|-----------------------|----------|----------|----------|---------|
|                  |                       | 0-Group  | I-Group  | 0-Group  | 0-Group |
| Skagerak.....    | 16                    | 38 (46)  | 9 (18)   | 0.0(0)   |         |
| N. Kattegat..... | 15                    | 135 (68) | 78 (46)  | 0.4(0.6) |         |
| C. Kattegat..... | 17                    | 27 (27)  | 3 (8)    | 9 (1)    |         |
| S. Kattegat..... | 16                    | 4 (26)   | 1 (2)    | 0.0(0.4) |         |
| Sound.....       | 15                    | 2 (20)   | 0.9(2)   | 16 (20)  |         |
| Belts.....       | 89                    | 2 (25)   | 2 (2)    | 0.8(8)   |         |
| W. Baltic.....   | 12                    | 0.6(12)  | 0.3(0.4) | 0.0(4)   |         |

In brackets mean for 1927—49.

The number of I-group plaice was above the normal in the northern Kattegat, where the 0-group was well represented in 1950.

The prospects for the plaice fishery in the Kattegat in 1952 were good because the plaice from the rich year-class 1950 found in the northern Kattegat begins to recruit the stock of commercial plaice. For the Belt Sea the fishery yield of plaice should be expected to be about the normal, being based mostly on the year-class 1950. In the Sound the stock should be expected to be improving in 1952 because many of the 0-group were found here in 1950.

The number of 0-group flounder was above the mean in the central Kattegat and below the mean in the Belts. Some sheltered areas with muddy bottom in the Belts which are preferred by the young flounder have been investigated by quantitative fishing during the latest two years. Here the number of 0-group flounder in 1951 was less than in 1950, but the density found at the open coast was about the same in these years.

As usual the number of turbot caught was very small.

AAGE J. C. JENSEN.

#### 2. The Stock of Plaice in the open Sea.

Quantitative fishing was carried out from S/S "Biologen" partly with the eel-tog used as a standard implement and partly with a 50 foot trawl of a construction used commercially but with a fine meshed cod-end (18 mm. knot-knot). This caught about 4 times as many plaice per time-unit as the eel-tog. The average number of plaice caught are shown in Table 6 A and B; the results of the fishery in the

**Table 6. Number of the various Age-Groups of Plaice caught per 1 hour with the Eel-Tog (A) and with the Trawl (B).**

In brackets averages from 1927—39.

| A.                    | No.<br>of St. | 0       | I        | II       | III       | IV +    |     |
|-----------------------|---------------|---------|----------|----------|-----------|---------|-----|
| C. and S.<br>Kattegat |               |         |          |          |           |         |     |
| 5—14 m.               | 3             | 0 (9)   | 44 (161) | 14 (153) | 0 (44)    | 0 (1.4) |     |
| 15—24 m.              | 3             | 0 (0.2) | 0 (76)   | 1 (117)  | 2 (49)    | 0 (0.5) |     |
| Belts                 |               |         |          |          |           |         |     |
| 5—14 m.               | 5             | 0 (3)   | 8 (7)    | 3 (5)    | 0.4 (2)   | 0 (0.2) |     |
| 15—34 m.              | 21            | 0 (0.4) | 7 (1.6)  | 2 (1.5)  | 0.5 (0.6) | 0 (0.3) |     |
| B.                    | No.<br>of St. | 0       | I        | II       | III       | IV +    |     |
| Month                 |               |         |          |          |           |         |     |
| Northern<br>Kattegat  |               |         |          |          |           |         |     |
| 25—34 m.              | III-VI        | 4       | 0        | 5        | 8         | 2       | 0.5 |
| C. and S. Kattegat    |               |         |          |          |           |         |     |
| 5—14 m.               | VI-IX         | 4       | 0        | 45       | 78        | 22      | —   |
| 15—34 m.              | IV-X          | 16      | 0        | 0        | 1.2       | 1.0     | —   |
| Belts                 |               |         |          |          |           |         |     |
| 5—14 m.               | IV-VII        | 4       | 0        | 13       | 10        | 0.5     | —   |
|                       | VIII-X        | 10      | 0        | 8        | 29        | 3       | —   |
| 15—34 m.              | IV-VII        | 26      | 0        | 1.8      | 13        | 1.8     | —   |
|                       | VIII-X        | 10      | 0        | 57       | 25        | 1.4     | —   |
| Sound                 |               |         |          |          |           |         |     |
| 12—22 m.              | IV-X          | 4       | —        | 0.5      | 11        | 5       | 4   |

northern Kattegat where the eel-tog was used only at one station and the trawl-caught plaice have only been partially age-analysed, and the results of the eel-tog fishery in the Sound and the trawl fishery in the western Baltic where only a few plaice were caught are not included.

The number of the I-group plaice (year-class 1950) was very great in the northern Kattegat corresponding to the great amount of the 0-group found in the coastal regions in 1950.

In the central and southern Kattegat the densities of I-group and II-group plaice were below the normal as was the frequency of the 0-group of these year-classes at the coasts. Also the density of the III-group (year-class 1948) was small although this year-class was found in great quantities as 0-group in 1948. In this region the density of the year-class was normal in 1949 and about two thirds of the normal in 1950. It has decreased in density very rapidly. Surely the intensity of fishing is higher than in the period 1927—39 for which the "normal" density is calculated.

In the Sound rather many III-group and older plaice were caught at a trawl station in

April and rather many II-group at 3 trawl stations in October.

In the Belts the density of the II-group (year-class 1949) was found to be about the normal but the number of the I-group (year-class 1950) was above the normal.

From Table 6 A and B it appears that the density of the I-group plaice was above the normal only at depths over 15 m. in Aug.—Oct. The richness of the 1950 year-class in the depths above 15 m. in the Belts is greater than it was to be expected from the quantitative fishing for the 0-group at the coasts, where its strength was found to be only about the normal in the Belts and the western Baltic. In the western Baltic practically no plaice were found in the quantitative fishing experiments and the richness of the 1950 year-class in the lower water layer of the Belts may partly be explained by an immigration from the western Baltic.

AAGE J. C. JENSEN.

### 3. The Limfjord Stock of Plaice.

Investigations were carried out by means of the eel-tog in June and in September. The numbers caught per 1 hour are shown below. Numbers in brackets give the means for the period 1927—39:

|        | Nissum Br. | Veno-Kås Br. | Salling-sund | Livø Br. | Thisted-Visby Br. | Sal-ling |
|--------|------------|--------------|--------------|----------|-------------------|----------|
| Summer | 466(712)   | 62(168)      | 14(92)       | 4.2(12)  | 3.2(24)           | 9(10)    |
| Autumn | 970(962)   | 14(184)      | 11(24)       | 0.8(4)   | 0 (7)             | 0(2)     |

In the autumn of 1951 the catch in the Nissum Broad was about normal, in June it was however far below normal. In all the other parts the catch was below the normal in summer and autumn. The catches in autumn were especially small.

The age composition of the stock in Nissum Broad was as follows (catch per hour); means for 1927—39 in brackets.

| Age-group | Year-class | June      | September |
|-----------|------------|-----------|-----------|
| 0         | 1951       | —         | 74 ( 80)  |
| I         | 1950       | 284 (152) | 652 (448) |
| II        | 1949       | 140 (308) | 212 (298) |
| III       | 1948       | 34 (206)  | 28 (124)  |
| IV+       | 1947—      | 8 ( 54)   | 2 ( 34)   |

Thus the 0-group was very near the normal strength, and the I-group somewhat above the normal. The older age-groups were, however, far below the normal.

The good representation of the 2 youngest year-classes promises a somewhat better plaice fishery in the Limfjord in the near future.



In order to investigate to what effect the fishery in the Nisum Broad for young plaice for transplantation affects the stock in this area, fishing experiments were carried out in the broad in March just before the transplantation took place; in the following table the catches in March are compared with those from June (catches per 1 hour in Nisum Broad):

|                   | March | June |
|-------------------|-------|------|
| I-group . . . .   | 90    | 284  |
| II-group . . . .  | 118   | 140  |
| III-group . . . . | 18    | 34   |
| IV+ -group . . .  | 0     | 8    |

The fact that the catch in June is far bigger than in March both as regards the III- and IV-group, which are mainly fished upon for transplantation, and the I- and II-group shows that the immigration from the North Sea is so strong that it easily covers the loss caused by the fishing for transplantation.

ERIK M. POULSEN.

#### 4. Market Measurements of Plaice.

The length distribution of some catches which were taken at the same depths and in the same season in 1951 and in previous years are shown in Table 7.

To the north of the Seaw at depths up to 30 m. the average length of the plaice in February-March was about the same in 1950

**Table 7. Length Composition of Plaice (‰) in commercial Catches from the Kattegat.**

| Danish Seine.                      |                   |             |                   |           |           |           |           |      |  |
|------------------------------------|-------------------|-------------|-------------------|-----------|-----------|-----------|-----------|------|--|
|                                    | No. of<br>Catches | Depth<br>m. | Length-Group, cm. |           |           |           |           | Mean |  |
|                                    |                   |             | 26-<br>30         | 31-<br>35 | 36-<br>40 | 41-<br>45 | 46-<br>50 | mm.  |  |
| North of the Seaw                  |                   |             |                   |           |           |           |           |      |  |
| 1950, Feb.-Mar.                    | 3                 | 23—26       | 43                | 40        | 12        | 4         | 1         | 323  |  |
| 1951, March. . .                   | 1                 | 27          | 42                | 41        | 17        | —         | —         | 322  |  |
|                                    |                   |             |                   |           |           |           |           |      |  |
| 1950, March. . .                   | 2                 | 28—56       | 15                | 54        | 24        | 7         | —         | 346  |  |
| 1951, Feb.-Mar.                    | 3                 | 26—56       | 26                | 58        | 15        | 1         | —         | 328  |  |
|                                    |                   |             |                   |           |           |           |           |      |  |
| At Ålborg Bay Lightvessel          |                   |             |                   |           |           |           |           |      |  |
| 1950, Oct. . . . .                 | 1                 | 12          | 66                | 30        | 3         | 1         | —         | 303  |  |
| 1951, Oct. . . . .                 | 1                 | 12          | 49                | 45        | 6         | —         | —         | 309  |  |
|                                    |                   |             |                   |           |           |           |           |      |  |
| 5—10 naut. miles N. E. of Fornæs   |                   |             |                   |           |           |           |           |      |  |
| 1950, Nov. . . . .                 | 1                 | 18          | 37                | 33        | 22        | 8         | —         | 337  |  |
| 1951, Nov. . . . .                 | 1                 | 18          | 22                | 57        | 19        | 2         | —         | 339  |  |
|                                    |                   |             |                   |           |           |           |           |      |  |
| At Schultz's Ground, Hastens Grund |                   |             |                   |           |           |           |           |      |  |
| 1950, Apr., May,<br>June . . . . . | 4                 | 15—24       | 55                | 31        | 13        | 1         | —         | 313  |  |
| 1951, May. . . . .                 | 2                 | 11—18       | 42                | 42        | 12        | 4         | —         | 318  |  |

and 1951. In 1951 there were proportionally less plaice just over the minimum limit because most plaice of the rich year-class 1948 were between 28—35 cm. in length, and most of the plaice from the latest years of the war had now been fished. The disappearance of the larger plaice must be the cause for the mean length in depths greater than 30 m. being about 2 cm. less in 1951 than in 1950.

In the central and southern Kattegat the average length was about the same in the two years. It must be expected that the mean length will decrease a little in 1952 because many plaice of the 1950 year-class will grow up over the minimum limit during this year.

AAGE J. C. JENSEN.

#### 5. Transplantations of Plaice.

(a) **Denmark.** The transplantations of young plaice to the inner Danish waters were continued. In April 160,000 kg. (or about 1.8 mill. ind.) were caught in the Nisum Broad for transplantation. Samples were examined as to age, length, and number of anal fin rays.

| Age-Group | Year-Class | Number analysed | %  | Mean Length cm. | No. of Anal Fin Rays |
|-----------|------------|-----------------|----|-----------------|----------------------|
| I         | 1950       | 5               | 1  | —               | —                    |
| II        | 1949       | 278             | 56 | 18.1            | 54.26                |
| III       | 1948       | 209             | 42 | 21.4            | 54.60                |
| IV        | 1947       | 9               | 1  | —               | —                    |

The mean length of the II- and III-groups was about 4 cm. above normal which is in good accordance with the only sparse population of plaice in the Nisum Broad during the years 1949—51.

The transplantations to the Belt Sea and adjacent waters comprised the following quantities:

|                             | Tons | Thousand Fish |
|-----------------------------|------|---------------|
| Laeso . . . . .             | 4    | 51            |
| Southern Kattegat . . . . . | 8.5  | 93            |
| The Sound . . . . .         | 3.9  | 42            |
| N. Belt Sea . . . . .       | 26.1 | 291           |
| S. Belt Sea . . . . .       | 18.3 | 203           |
| W. Baltic . . . . .         | 15.3 | 174           |
| Total . . . . .             | 76.1 | 854           |

The quantity transplanted was somewhat less than in 1950 (129 tons).

Part of the plaice were transported over land in tanks with oxygenated seawater. This method yielded on a whole as good results as the seatransport.

800 plaice were marked; at the end of the year 13% had been recaptured, a considerably higher figure than in the preceding year (7%).

In the Limfjord the following quantities were transplanted to the inner broads: 84 tons = 968,000 individuals or only about half as much as in 1950.

Of 700 marked plaice about 40 % were recaptured by the end of the year; this is a considerably better result than in the immediately preceding years (20—30 %).

ERIK M. POULSEN.

(b) *Norway*. A transplantation of plaice from Nissum Broad (Limfjord) was effected on 30th April, 4000 kg., approximately 45,000 young plaice, were liberated in the inner Oslofjord. The average weight was 88.5 g., the average length 20.77 cm. Age determinations showed this composition:

| Group | %     | Group | %    |
|-------|-------|-------|------|
| I     | 0.25  | V     | 0.96 |
| II    | 50.96 | VI    | 0.25 |
| III   | 36.23 | VII   | 0.25 |
| IV    | 11.11 |       |      |

201 plaice were marked with the usual black ebony discs. So far the returns are insignificant. The experiment was sponsored by the Society for the Promotion of the Fishery in the Oslofjord, and the expenses were covered by grants from the Fishermens Organizations and from the City of Oslo.

JOHAN T. RUUD.

#### 6. Flounder and Turbot in the Limfjord.

The stock of flounder was below normal. In various areas the following numbers were caught per 1 hour with the eel-tog. In brackets means for 1927—46.

|           | Nissum Br. | Venø-Kås Br.      | Sallingsund   |
|-----------|------------|-------------------|---------------|
| June..... | 0.6 (0.8)  | 0.4 (2.0)         | 2.0 (2.0)     |
| Sept..... | 5.2 (0.8)  | 0 (0.6)           | 0 (1.0)       |
|           | Livø Br.   | Thisted-Visby Br. | E. of Salling |
| June..... | 1.6 (5.2)  | 0 (3.0)           | 4.0 (6.0)     |
| Sept..... | 1.0 (4.6)  | 0 (1.4)           | 0 (1.8)       |

In Nissum Broad the stock was above normal, but in all other waters, as in the previous years, it was much below normal.

In the western and the central part of the Limfjord the numbers of turbot were normal, but in Thisted Broad and E. of Salling the density was above the normal for the period 1927—46.

J. B. KIRKEGAARD.

### Dab.

#### 1. Limfjord Stock.

In 1951 the following numbers of dab were caught per 1 hour with the eel-tog. The numbers are means of June and September, in brackets are means for 1927—46.

| Nissum Br. | Venø-Kås Br.      | Sallingsund   | Livø Br. |
|------------|-------------------|---------------|----------|
| 154 (158)  | 11 (40)           | 4 (26)        | 0.6 (3)  |
|            | Thisted-Visby Br. | E. of Salling |          |
|            | 0.4 (1.4)         | 1 (0.8)       |          |

The stock of dab in 1951 was thus normal in Nissum Br. and E. of Salling, in all other waters below normal, but the average for the whole Limfjord was the largest since the war.

J. B. KIRKEGAARD.

#### 2. Other Danish Waters.

During the fishing from S/S "Biologen" with the eel-tog and the trawl a large number of dab were obtained, although the hauls with the first-mentioned gear showed that the stock was much reduced as compared to previous years. The following table will show the number per 1 hour haul with the eel-tog in the different parts of the Transition Area.

|                  | Number<br>of Hauls | Number<br>per 1 Hour | Average Number<br>per 1 Hour<br>1930—39 |
|------------------|--------------------|----------------------|-----------------------------------------|
| N. Kattegat..... | 1                  | 153                  | 310                                     |
| C. Kattegat..... | 3                  | 14.7                 | 69                                      |
| S. Kattegat..... | 3                  | 39                   | 127                                     |
| Belts.....       | 26                 | 69                   | 176                                     |
| W. Baltic.....   | 6                  | 7.7                  | 93                                      |

From the above it appears, that the stock of dab in all areas of the Belt Sea was considerably below normal. The stock was smaller in 1951 than in 1950 (vide Ann. Biol. VII, p. 108) in all areas except in the Belts where a slight increase was found.

In the hauls with the trawl much larger quantities of dab were obtained as will appear from the following table giving the number per 1 hour haul:

|                  | Number<br>of Hauls | Number<br>per 1 Hour |
|------------------|--------------------|----------------------|
| Skagerak.....    | 3                  | 150                  |
| N. Kattegat..... | 14                 | 174                  |
| C. Kattegat..... | 4                  | 73                   |
| S. Kattegat..... | 21                 | 206                  |
| Belts.....       | 55                 | 141                  |
| W. Baltic.....   | 9                  | 36                   |

Age determinations by means of otoliths were carried out on all specimens obtained from the eel-tog. The results were as follows:

|                 | Total Number<br>of Specimens<br>examined | I-Gr.<br>(1950)<br>% | II-Gr.<br>(1949)<br>% | III+-Gr.<br>(1948—)<br>% |
|-----------------|------------------------------------------|----------------------|-----------------------|--------------------------|
| N. Kattegat.... | 153                                      | 92                   | 8                     | 0                        |
| C. Kattegat.... | 44                                       | 86                   | 14                    | 0                        |
| S. Kattegat.... | 118                                      | 5                    | 60                    | 35                       |
| Belts.....      | 1408                                     | 62                   | 32                    | 7                        |
| W. Baltic.....  | 16                                       | 10                   | 80                    | 10                       |

It appears that in the northern and central Kattegat the I-group predominated, the II-group being of slight importance and III-group and older entirely absent. In the southern Kattegat the II-group was the most important followed by the III-group, the I-gr. being almost absent. In the Belts the I-group predominated, the II-gr. forming only 32 % of the stock, while older specimens were scarce. In the western Baltic the II-gr. predominated.

Counts of anal fin rays and vertebrae were made on a number of specimens of the II-gr. (1949 year-class). The result of the countings may be summarized as follows:

|               | No. of Anal<br>Fin Rays | Number<br>examined | Number of<br>Vertebrae | Number<br>examined |
|---------------|-------------------------|--------------------|------------------------|--------------------|
| N. Kattegat.. | 54.02                   | 10                 | —                      | —                  |
| C. Kattegat.. | 54.70                   | 7                  | —                      | —                  |
| S. Kattegat.. | 55.72                   | 43                 | —                      | —                  |
| N. Belt Sea.. | 55.77                   | 271                | 40.25                  | 99                 |
| S. Belt Sea.. | 55.08                   | 250                | 40.28                  | 88                 |
| W. Baltic...  | 55.13                   | 16                 | —                      | —                  |

Compared with the year-class 1948 (vide Ann. Biol. VII, p. 108) the 1949 year-class in the S. Kattegat, the Belts and the W. Baltic appears to have a very high number of anal fin rays, exceeding in all areas 55, while in the 1948 year-class the number of anal fin rays varied between 53.37 and 53.70. Also the average number of vertebrae was higher in the 1949 year-class than in the previous one.

J. KNUDSEN.

## Mackerel.

Prospects for the yield of the mackerel fishery in the Skagerak and the northernmost Kattegat were given from the meteorological-hydrographical conditions during the first months of the year. A yield over the normal was to be expected. From reports to the Ministry from the fishery control this might seem to have been near the mark.

AAGE J. C. JENSEN.

## Eel.

### 1. Isefjord-Roskildefjord.

Quantitative hauls with the eel-seine carried out from the motorboat "Havkatten" in September at 11 stations showed that the density of eels was much greater than in the previous years. In the Roskildefjord it was about 40 per hour (5 hauls of which the results of 1 or 2 is dubious) against 34 and 18 per hour in 1949 and 1950, respectively. A mean of 63 per hour (3 stations) was found in the inner broad of the Isefjord against 23 and 33, respectively, in the two previous years. In the outer broad of the Isefjord a total of 36 was found at one station, and in the Lammefjord, where seine fishing is prohibited, a mean of 42 were found at 2 stations.

### 2. Prediction.

Prediction of the yield of the silver-eel fishery was given from the summer temperature of the water. It was to be expected that it should be 5—10 % above the normal in the Belt Sea and the Limfjord. Actually it was less than normal at most places undoubtedly because the unusually quiet wind conditions during the fishing season were unfavourable to the yield.

AAGE J. C. JENSEN.

## Fish for Processing.

The Danish fishery for fish-meal factories, fish-pond food and for food in fox-farms has been continued and showed for the year 1951 a considerable increase to ca. 110 mill. kg. (see table below). This fishery is now the most important one as to weight. In value it nearly equals the cod fishery, which for many years has been No. 2, the value of the plaice fishery being No. 1. The catch (in tons) in the various Danish waters was distributed in the following way:

|                      | 1949   | 1950   | 1951    |
|----------------------|--------|--------|---------|
| North Sea.....       | 3,003  | 6,811  | 34,000  |
| Skagerak.....        | 14,224 | 29,067 | 47,000  |
| Kattegat.....        | 21,464 | 21,522 | 23,000  |
| Sound.....           | 21     | —      | 3       |
| Belts.....           | 1,613  | 2,856  | 3,200   |
| Western Baltic.....  | —      | 51     | 110     |
| Eastern Baltic.....  | 295    | 118    | 110     |
| Ringkøbing Fjord.... | 4      | 5      | 16      |
| Nissum Fjord.....    | 11     | 7      | 15      |
| Limfjord.....        | 402    | 1,680  | 2,500   |
| Total.....           | 41,237 | 62,117 | 109,954 |



The greater part of the fish was caught in the Skagerak, North Sea and Kattegat and the main landing ports were Skagen, Esbjerg and Frederikshavn. From the figures it will be seen that the yield in the North Sea has increased very much.

A great fishery for young herring (about 7 cm. in length) took place in the summer months at 2—4 m. depth at the shores of the northern Kattegat and Skagerak.

During the last two years a new fishery for fish for processing has developed at the Clay Deep and east of this deep north of White Bank, at the "Bløden" ground (the soft ground). The catches consist mainly of immature herring (17—22 cm.), which sometimes are mixed with whiting.

The catch in each of the other regions has also increased. During the year 10 samples from the northern area (Skagerak and northern Kattegat) and 80 samples from the southern area (the Belt Sea) were investigated partly at the harbours and partly at the laboratory of the Danish Biological Station. The species found in the samples and their percentage abundance by weight are given in the Table 8 below.

The material of the southern area is divided into an open and a closed period, because landings containing more than 50 % small herrings are not allowed in this area between 15/4—30/9. This interdiction was repealed in 1951 for the northern area.

The wastefish fishery in Kalundborg Fjord is given in a separate column, because this fishery is carried out with a special wide-meshed gear.

In the northern area the average contents of the catches in the small-meshed gears were about the same as in the preceding year.

In the southern area the composition of the catches in the small-meshed gears had changed very much. The percentage of whiting and herring during the months when landing of small herring was allowed decreased from 1949—50 to 1951 to about 50 %, but the percentage of sprat increased to more than double of what was found in 1949—50.

According to the reports to the Ministry from the fishery controllers (whose duty it is to examine the wastefish species) the landings consisted mainly of sprat (at some ports almost exclusively) but some small whittings were also found. Sprat constituted also the bulk in the samples investigated during the summer months, but they may not be fully representative for the catches.

I. BOHUS JENSEN.

### Hatching and Rearing.

The cod hatchery was not worked in 1951. Experimental rearing of plaice was very successful. The rearing of herring resulted in some hundreds now living in our aquaria, 10 months of age. In post larval stages we had some mortality evidently caused by *Lentospora cerebralis*. Later we lost some individuals from infections of the intestines caused by undigestible particles swallowed with the food.

The cod larvae thrived for some weeks, but they gradually died, probably by infection by *Vibrio anguillarum*. The plaice was also infected, but here the attack was stopped by adding some salt to the sea water.

The rearing of lobsters was not carried on in 1951. Some experiments were undertaken to hatch eggs removed from the female.

ALF DANNEVIG.

Table 8. Percentage Weight of Species found in Samples.

| Mesh (knot to knot)    | South area excl. Kalundborg Fjord |                        |            |            | Kalundborg Fjord<br>The whole year | North area<br>The whole year |
|------------------------|-----------------------------------|------------------------|------------|------------|------------------------------------|------------------------------|
|                        | 1/1—15/4 and 15/4—30/9            | 1/1—15/4 and 15/4—30/9 | 1/10—31/12 | 1/10—31/12 |                                    |                              |
|                        | 11—15 mm.                         | 11—15 mm.              | 16—20 mm.  | 16—20 mm.  |                                    |                              |
| No. of samples.....    | 19                                | 4                      | 26         | 7          | 24                                 | 10                           |
| Whiting.....           | 11.3                              | 0.2                    | 31.5       | 71.4       | 98.8                               | 26.6                         |
| Herring.....           | 20.1                              | 0.4                    | 35.9       | 1.8        | —                                  | 44.4                         |
| Sprat.....             | 67.0                              | 99.4                   | 29.9       | 26.7       | 0.03                               | 23.1                         |
| Other food-fishes..... | 1.4                               | —                      | 0.6        | —          | 0.03                               | 2.0                          |
| Other fishes.....      | 0.3                               | —                      | 2.0        | —          | 1.1                                | 3.7                          |
| Invertebrates.....     | —                                 | —                      | —          | —          | —                                  | 0.4                          |

## SHELLFISH

### Deep Sea Prawn.

The investigations of the prawn fishery in the Skagerak were continued, and trawl hauls with bigger and smaller meshes in the cod-end were carried out. The results from the preceding years, that considerable quantities of smaller prawns are saved by using larger meshed cod-ends, were confirmed.

ERIK M. POULSEN.

### Oyster.

The oyster cultures in the natural ponds suffered very much during the extraordinarily

cold winter. The snow and ice broke down the constructions carrying the oyster baskets, and a heavy mortality followed. The spawning of the oyster in the artificial pond at Flødevigen was successful, a fair quantity of spat was collected.

ALF DANNEVIG.

### Lobster.

The statistics of 25 fishermen proved that the fishing along the Norwegian Skagerak coast resulted in 6.5 lobster per trap — somewhat more than in 1950.

ALF DANNEVIG.

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# Baltic Area.

## INTRODUCTION

Contributions to this report have been received from Dr. AAGE J. C. JENSEN, Copenhagen, Mr. HELGE THOMSEN, Copenhagen, Dr. STEN VALLIN, Drottningholm and Dr. F. F. KOCZY, Gothenburg.

### Environment.

As for the previous year THOMSEN has compiled a table of the monthly means of surface temperature and salinity at Christiansø in the Bornholm district and has made an isopleth diagram showing the variations of the oxygen contents at different depths in the Bornholm Deep in each month.

Koczy contributes with reports on temperature and salinity in the surface and bottom layers at Swedish lightships in the different months of the year and on hydrographical investigations in the deep basins of the Central Baltic in January and July.

The temperature of the upper water-layers seems, at least in the greater part of the area, to have been somewhat below normal during spring and summer but above normal in the months September to December.

A renewal of the bottom water in the Bornholm Basin took place in April and again in November-December. Of special interest is the extraordinarily high salinity, 21.56 ‰, observed in December in this basin, which probably is the highest salinity ever recorded in this locality.

The temperature and salinity in the Landsort Deep increased between January and July indicating a renewal of the deeper water-masses.

JENSEN gives a survey of his observations on the fat content of the plankton in the Bornholm district in 1951.

In 1950 the copepod *Eurytemora hirundoides* which constitutes a very great part of the zooplankton of the Gulf of Bothnia was infected by a parasitic water-mould and died in great masses, causing inconvenience to the fishery in certain parts of that area. This mould appeared again in 1951 but the attack was much weaker. VALLIN reports on his investigations of this interesting phenomenon.

### Fish Species.

Surveys are given by JENSEN of Danish fishing experiments with eel-tog, Johansen young-plaice trawl, hand push-net and trawl at different localities in the western part of the area and in the Bornholm district.

The investigations indicate that the stock of flatfishes is still very weak and that an improvement of this stock is hardly to be expected in a near future. On the other hand the stock of cod seems to maintain its strength.

CHR. HESSLE.



## ENVIRONMENT

### Hydrography.

#### Danish Observations.

**Table 1. Monthly Means of Surface Temperature and Salinity at Christianso, 1951.**

(From the Danish Meteorological Institute, Nautical Department).

|             | I   | II  | III | IV  | V   | VI   | VII  | VIII | IX   | X    | XI  | XII |
|-------------|-----|-----|-----|-----|-----|------|------|------|------|------|-----|-----|
| Temp.....   | 3.6 | 2.2 | 1.8 | 3.0 | 6.4 | 11.7 | 15.0 | 16.7 | 16.5 | 13.5 | 9.8 | 6.9 |
| Sal. ‰..... | 7.5 | 7.4 | 7.4 | 7.6 | 7.6 | 7.6  | 7.4  | 7.5  | 7.4  | 7.4  | 7.5 | 8.0 |

The monthly mean temperatures did not deviate much from the normal during the first 8 months of the year, but in September and October the mean temperature was  $2.4^{\circ}$  above normal, in November  $1.7^{\circ}$  and in December  $1.4^{\circ}$  above normal.

The salinity was  $1.0$  ‰ above normal in December, but never greater than  $0.6$  ‰ above normal during the rest of the year.

The variation of the oxygen contents in the Bornholm Deep is displayed in the isopleth diagram, Figure 1.

A renewal of the bottom layer took place in April and again in November/December. The latter was caused by an inflow of water of extraordinarily high salinity. On 29. December a bottom salinity of  $21.56$  ‰ was observed at a depth of 100 metres. This is the highest salinity ever recorded in this locality.

HELGE THOMSEN.



Figure 1. Isopleth diagram showing the variation of oxygen contents (ml/l.) in the Bornholm Deep, 1.5 naut. mile ESE. of Christianso.

#### Swedish Observations.

The extraordinary late winter, cold summer and late but warm autumn is reflected in the surface temperatures at the lightships in the Baltic as Table 3 clearly shows. The mean temperature for July is exceptionally low but during the last four months of the year the surface temperature is considerably higher than the normal values.

**Table 2. The Salinity at the Surface and Bottom at the Lightships in the Baltic measured the 1st each month.**

| Lightships         | Depth m. | I    | II   | III  | IV   | V    | VI    | VII   | VIII | IX    | X    | XI    | XII   |
|--------------------|----------|------|------|------|------|------|-------|-------|------|-------|------|-------|-------|
| Sydostbrotten..... | 0        | 5.66 | —    | —    | —    | —    | 5.14  | 5.25  | 4.15 | 5.38  | 4.26 | 5.26  | 5.58  |
|                    | 40       | 5.83 | —    | —    | —    | —    | 5.97  | 5.85  | 5.79 | 5.34  | 5.85 | 5.45  | 5.67  |
| Fjngrundet.....    | 0        | 5.64 | 5.56 | 5.68 | —    | —    | 5.78  | 5.76  | 5.66 | 5.62  | 5.50 | 5.50  | 5.41  |
|                    | 30       | 5.67 | 5.57 | 5.63 | —    | —    | 5.60  | 5.71  | 5.72 | 5.66  | 5.59 | 5.77  | 5.61  |
| Grundkallen.....   | 0        | 5.53 | 5.66 | 5.90 | —    | 5.59 | 5.83  | 5.66  | 5.61 | 5.82  | 5.58 | 5.51  | 5.67  |
|                    | 40       | 5.58 | 5.84 | 6.04 | —    | 5.66 | 6.26  | 5.85  | 5.97 | 5.91  | 5.78 | 5.70  | 6.31  |
| Svenska Björn..... | 0        | 6.51 | 6.20 | 6.69 | —    | 6.19 | 6.06  | 6.00  | 5.72 | 5.97  | 6.02 | 6.17  | 6.57  |
|                    | 40       | 6.63 | 6.76 | 6.78 | —    | 7.06 | 7.36  | 7.34  | 7.93 | 6.42  | 6.96 | 7.27  | 6.65  |
| Hävringe.....      | 0        | —    | —    | —    | —    | —    | —     | —     | —    | —     | —    | 7.30  | 7.58  |
|                    | 40       | —    | —    | —    | —    | —    | —     | —     | —    | —     | —    | 7.64  | 9.56  |
| Ölandsrev.....     | 0        | 7.17 | 7.16 | 7.28 | 7.18 | 7.11 | 7.02  | 7.30  | 7.57 | —     | —    | —     | —     |
|                    | 40       | 7.18 | 7.18 | 7.27 | 7.17 | 7.18 | 7.27  | 7.69  | 7.56 | —     | —    | —     | —     |
| Falsterborev.....  | 0        | 8.13 | 7.71 | 7.50 | 7.69 | 7.92 | 7.36  | 7.53  | 7.68 | 7.99  | 8.10 | 8.09  | 10.46 |
|                    | 10       | 8.15 | 7.49 | 7.50 | 7.71 | 7.93 | 7.35  | 7.72  | 7.71 | 8.05  | 8.09 | 8.09  | 11.10 |
| Oskarsgrund.....   | 0        | 8.67 | 7.76 | 8.74 | 8.80 | 8.12 | 7.61  | 10.12 | 8.68 | 9.58  | 8.16 | 9.39  | 24.48 |
|                    | 8        | 8.67 | 7.77 | 9.07 | 8.70 | 8.14 | 21.24 | 10.12 | 8.45 | 15.01 | 8.17 | 22.91 | 24.47 |

**Table 3. The Mean Temperature at the Surface and Bottom at Lightships in the Baltic.**

| Lightships         | Depth m. | I   | II  | III | IV  | V   | VI   | VII  | VIII | IX   | X    | XI  | XII |
|--------------------|----------|-----|-----|-----|-----|-----|------|------|------|------|------|-----|-----|
| Sydöstbrotten..... | 0        | —   | —   | —   | —   | —   | 8.7  | 12.3 | 14.3 | 13.9 | 10.2 | 6.7 | 3.5 |
|                    | 40       | —   | —   | —   | —   | —   | 2.1  | 1.8  | 7.4  | 6.3  | 6.0  | 7.2 | 4.1 |
| Finngrundet.....   | 0        | 1.4 | 0.0 | —   | —   | 2.5 | 6.8  | 11.3 | 14.6 | 12.9 | 10.0 | 5.7 | 2.3 |
|                    | 30       | 1.4 | 0.2 | —   | —   | 2.3 | 3.9  | 3.9  | 5.1  | 4.8  | 5.6  | 4.7 | 2.4 |
| Grundkallen.....   | 0        | 1.2 | 0.6 | —   | —   | 2.7 | 7.8  | 12.3 | 14.9 | 14.0 | 10.6 | 7.0 | 2.5 |
|                    | 40       | 1.7 | 1.3 | —   | —   | 2.1 | 3.6  | 4.3  | 4.1  | 4.3  | 4.9  | 4.7 | 2.8 |
| Svenska Björn..... | 0        | 2.6 | 1.0 | —   | —   | 4.0 | 8.6  | 13.1 | 14.9 | 13.8 | 10.8 | 7.5 | 4.2 |
|                    | 40       | 3.0 | 1.5 | —   | —   | 2.0 | 3.0  | 3.6  | 4.5  | 4.2  | 4.9  | 6.3 | 4.6 |
| Hävringe.....      | 0        | —   | —   | —   | —   | —   | —    | —    | —    | —    | —    | 8.0 | 4.9 |
|                    | 40       | —   | —   | —   | —   | —   | —    | —    | —    | —    | —    | 7.1 | 4.5 |
| Ölandsrev.....     | 0        | 3.7 | 2.4 | 1.7 | 2.5 | 5.2 | 10.8 | 13.2 | 15.5 | —    | —    | —   | —   |
|                    | 40       | 3.8 | 2.4 | 1.8 | 2.1 | 4.5 | 5.4  | 4.8  | 4.7  | —    | —    | —   | —   |
| Falsterborev.....  | 0        | 3.0 | 1.7 | 1.3 | 3.3 | 7.9 | 13.2 | 15.2 | 16.6 | 16.0 | 13.1 | 9.8 | 6.6 |
|                    | 10       | 3.0 | 1.7 | 1.3 | 3.3 | 7.8 | 12.9 | 14.8 | 16.5 | 16.0 | 13.2 | 9.8 | 6.8 |
| Oskarsgrund.....   | 0        | 2.7 | 1.6 | 1.6 | 3.8 | 8.1 | 13.9 | 15.6 | 16.4 | 15.8 | 12.4 | 9.3 | 6.2 |
|                    | 8        | 3.1 | 3.5 | 2.5 | 3.7 | 7.8 | 13.0 | 15.4 | 16.4 | 15.6 | 12.9 | 9.8 | 6.2 |

Table 2 shows the surface salinity values at the lightships as they were taken on the 1st of each month. At "Oskarsgrund" the twenty-permille-salinity-front apparently reaches the southern part of the Sound during December. In the bottom layer the front of the twenty-permille-salinity water is present near "Oskarsgrund" during June, November and December indicating that an inflow of high-salinity water into the Baltic has taken place.

The investigations of the hydrographic situation in the deep basins of the central Baltic

could be carried out in January and July. The results are given in Table 4. In January, Finnish scientists were participating on the cruise with the "Skagerak". The Gotland Deep below 80 m. shows no variations since January 1950. The temperature and salinity in the Landsort Deep increased between January and July indicating a renewal of the deeper water-masses. West of Gotland the salinity discontinuity layer has moved upward again and was found at the normal level of about 70 m.

**Table 4. Hydrographical Measurements in the Deep Basins of the Baltic.**

| West of Gotland,<br>57°45'N., 17°30'E.,<br>20th January |      |       |      |                               | Landsort Deep 58°38'N., 18°16'E.<br>30th January |      |       |      |                               | 13th July |       |       |  |  |
|---------------------------------------------------------|------|-------|------|-------------------------------|--------------------------------------------------|------|-------|------|-------------------------------|-----------|-------|-------|--|--|
| m.                                                      | °C.  | ‰ S   | pH   | PO <sub>4</sub> -P<br>μg-at/L | m.                                               | °C.  | ‰ S   | pH   | PO <sub>4</sub> -P<br>μg-at/L | m.        | °C.   | ‰ S   |  |  |
| 0                                                       | 3.25 | 6.98  | 8.11 | —                             | 0                                                | 1.76 | 6.72  | 8.12 | 0.08                          | 0         | 14.71 | 6.38  |  |  |
| 30                                                      | 3.24 | 6.89  | —    | 0.06                          | 10                                               | 1.82 | 6.68  | 8.12 | —                             | 10        | 14.20 | 6.38  |  |  |
| 50                                                      | 4.25 | 7.27  | —    | 0.08                          | 20                                               | 2.08 | 6.81  | 8.15 | 0.03                          | 15        | 13.15 | 6.38  |  |  |
| 80                                                      | 4.20 | 9.29  | —    | 0.7                           | 30                                               | 2.94 | 7.04  | 8.15 | —                             | 20        | 5.83  | 6.94  |  |  |
| 100                                                     | 4.31 | 10.07 | —    | 1.2                           | 40                                               | 3.39 | 7.24  | 8.14 | 0.06                          | 25        | 5.27  | 7.02  |  |  |
| 140                                                     | 4.39 | 10.29 | —    | 1.3                           | 50                                               | 4.20 | 7.41  | 8.14 | —                             | 30        | 5.48  | 7.09  |  |  |
| 170                                                     | 4.40 | 10.30 | —    | 1.2                           | 60                                               | 4.24 | 7.68  | 8.08 | 0.06                          | 40        | 5.49  | 7.21  |  |  |
|                                                         |      |       |      |                               | 80                                               | 4.29 | 9.15  | 8.10 | 1.0                           | 60        | 3.88  | 8.77  |  |  |
|                                                         |      |       |      |                               | 80                                               | —    | 9.83  |      |                               | 80        | 4.61  | 10.33 |  |  |
|                                                         |      |       |      |                               | 100                                              | 4.43 | 10.29 |      |                               | 100       | 4.71  | 10.66 |  |  |
|                                                         |      |       |      |                               | 150                                              | 4.58 | 10.50 |      |                               | 150       | 4.83  | 10.94 |  |  |
|                                                         |      |       |      |                               |                                                  |      |       |      |                               | 200       | 4.92  | 11.08 |  |  |
|                                                         |      |       |      |                               |                                                  |      |       |      |                               | 250       | 5.02  | 11.13 |  |  |
|                                                         |      |       |      |                               |                                                  |      |       |      |                               | 300       | 5.02  | 11.13 |  |  |
|                                                         |      |       |      |                               |                                                  |      |       |      |                               | 420       | 5.05  | 11.13 |  |  |

| Gotland Deep 57°20'N., 20°00'E.<br>3rd February |      |       |      |                               | 17th July |       |       |    |                               |
|-------------------------------------------------|------|-------|------|-------------------------------|-----------|-------|-------|----|-------------------------------|
| m.                                              | °C.  | ‰ S   | pH   | PO <sub>4</sub> -P<br>μg-at/L | m.        | °C.   | ‰ S   | pH | PO <sub>4</sub> -P<br>μg-at/L |
| 0                                               | 2.83 | 7.67  | 8.13 | 0.04                          | 0         | 15.97 | 7.12  |    |                               |
| 10                                              | 2.80 | 7.67  | 8.12 | —                             | 10        | 15.81 | 7.11  |    |                               |
| 20                                              | 2.82 | 7.67  | 8.11 | 0.04                          | 15        | 14.75 | 7.20  |    |                               |
| 30                                              | 2.80 | 7.67  | 8.10 | —                             | 20        | 7.02  | 7.29  |    |                               |
| 40                                              | 2.91 | 7.67  | 8.10 | 0.04                          | 30        | 3.74  | 7.38  |    |                               |
| 50                                              | 2.80 | 7.67  | 8.10 | —                             | 40        | 2.29  | 7.49  |    |                               |
| 60                                              | 3.16 | 7.68  | 8.11 | 0.04                          | 60        | 2.21  | 7.94  |    |                               |
| 80                                              | 4.55 | 9.44  | 7.32 | 1.0                           | 80        | 4.53  | 9.84  |    |                               |
| 100                                             | 5.07 | 10.20 | 7.34 | 1.0                           | 100       | 5.26  | 10.95 |    |                               |
| 150                                             | 5.44 | 12.33 | 7.26 | 1.8                           | 150       | 5.62  | 12.40 |    |                               |
| 200                                             | 5.68 | 12.72 | 7.25 | 1.8                           | 200       | 5.69  | 12.68 |    |                               |
|                                                 |      |       |      |                               | 235       | 5.78  | 12.82 |    |                               |

F. F. KOCZY.

## Plankton.

### Danish Observations.

The fat contents in plankton collected at Christiansø every 14th day, throughout the year, as far as the weather has permitted, are shown in Table 5 together with the fat contents in samples taken in August from S.S. "Biologen" at different localities.

**Table 5. Fat Contents in vertical Plankton Samples in 1952.**

|                          | No. of samples | Fat percentage mean | Fat percentage from-to |
|--------------------------|----------------|---------------------|------------------------|
| At Christiansø           |                |                     |                        |
| Jan.—March               | 4              | 17.0                | 12.6—22.0              |
| May—July                 | 5              | 27.1                | 22.9—32.8              |
| Aug.—Sept.               | 2              | 25.1                | 23.8—26.4              |
| October                  | 2              | 19.3                | 15.9—22.7              |
| South of Scania 12/8     | 2              | 9.4                 | 6.2—12.6               |
| Round Bornholm 12/8—19/8 | 12             | 13.5                | 8.6—24.0               |

It appears from Table 5 that the fat contents in August varied very much from one place to another. The highest values (19.7—24.0 %) were found in the neighbourhood of Christiansø, and they are of about the same size as those found from the continuous sampling. However, it is not certain that the fat contents at Christiansø were as high during the whole of August-September as found from the continuous sampling here because strong currents may sometimes have transported plankton from other places to this region. It is quite certain that the fat contents found at Christiansø are not always the mean of the fat contents at Bornholm.

AAGE J. C. JENSEN.

### Swedish Observations.

At the end of July and the beginning of August 1950 herring nets in the Swedish coastal waters of the Botten Sea were clogged with a sticky substance, which was found to consist of dead copepods belonging to the species *Eurytemora hirundoides* (NORDQUIST). They had been killed by a parasitic water-mould closely related to the species *Leptolegnia caudata*, DE BARRY. During the warmer months of the year this *Eurytemora* species is the most common copepod in the upper water layers in the Botten Sea and can be considered an important food for, above all, herring. Widespread death of

this copepod such as in the Botten Sea in 1950 could involve a temporary decrease in the herring fishery. A more palpable inconvenience to the fishery is the clogging of the nets with dead plankton. In August the mould had spread along the Swedish coast from Umeå in the north to Söderhamn in the south. It was also found in the open Botten Sea. A long period with calm warm weather with exceptionally high temperatures in the surface water — up to 20°C. in the open Sea and 23°C. in the archipelago — may have favoured the growth of the mould during summer.

In the summer of 1951 the *Eurytemora* mortality was not reported before the last days of August from the areas off Härnösand and Sundsvall. The appearance of the mould in the plankton about four weeks later and the less widespread plankton mortality than in 1950 may be associated with the rather cold summer in 1951.



Figure 2. Distribution of parasitic water-mould in *Eurytemora* during August 1950.

Areas with difficulties in herring fishery caused by nets being clogged with dead *Eurytemora*. *Eurytemora* attacked by the mould was found in plankton samples.  
The mould was not found in the samples.



The observations indicate that we may expect this *Eurytemora* mortality to appear in future years and to be more intense and widespread in years with warm summers.

STEN VALLIN.

#### Literature.

Ref. VALLIN, Plankton Mortality in the Northern Baltic caused by a parasitic water-mould. Inst. Freshwater Res. Rep. 32: 139—148.

## THE FISH

### Danish Investigations.

#### Cod.

At eel-tog stations at Møen in April (see below; Flatfish) rather many I-group cod were found. In August the II-group dominated at the trawl stations at Møen and to the south of Scania and the stock seemed to be rich, but we have for this implement no material for comparison with previous years. At Bornholm the stock was still richer. At 9 stations the length distribution shown in Table 6 was stated.

**Table 6. Length Distribution of  
Cod at Bornholm.**

(1 hour trawl catches, depths 71—95 m.)

| cm.-group:    |       |       |       |       |       |       |      |
|---------------|-------|-------|-------|-------|-------|-------|------|
| 6—10          | 11—15 | 16—20 | 21—25 | 26—30 | 31—35 | 36—40 |      |
| no. per hour: |       |       |       |       |       |       |      |
| 0.4           | 4     | 33    | 58    | 49    | 20    | 12    |      |
| 41—45         | 46—50 | 51—55 | 56—60 | 61—65 | 66—70 | 71—75 | > 76 |
| 8             | 10    | 4     | 2     | 1     | 0.2   | 1     | 1    |

Half of the number were of the II-group, a quarter of the I-group and about 7 % of the III-group. The presence of the many young cod gives reason to believe that a very great cod fishery in the Baltic will still prevail for some years.

It is of interest to note that as many as up to 15 % of the I-group cod had "Bulldog-noses", showing that the natural conditions for the health of the young fish in the Baltic may be rather bad.

#### Flatfishes.

##### 0- and I-Groups.

The quantitative fishing experiments along the coasts of Seeland and Møen on 6. and 7.

September and at Bornholm on 14.—15. August (see Table 7) showed that the number of 0-group plaice at the Seeland-Møen coast was about normal but that the number of 0-group flounder was very much below average. At Bornholm the numbers of the 0-group of plaice, flounder and turbot was above normal.

**Table 7. Number of 0-Group of Plaice,  
Flounder and Turbot on the Baltic Area  
Coasts of Denmark.**

Number caught per 1 hour with the Johansen young-plaice trawl at Seeland (6.—7. IX.) and with the hand push-net at Bornholm (14.—15. VIII.). Means for 1928—51 are given in brackets.

|              | Number of<br>stations | Plaice      | Flounder      | Turbot      |
|--------------|-----------------------|-------------|---------------|-------------|
| Seeland-Møen | 5                     | 4 (5)       | 25 (364)      | 0 (0.6)     |
| Bornholm...  | 13                    | ca. 40 (17) | ca. 393 (231) | ca. 34 (25) |

The number of 0-group plaice at Seeland-Møen was below normal in the years 1947—50 but at Bornholm it was in each of these years  $1\frac{1}{2}$ —2 times the normal and at Scania it was above the normal in 1948 and 1949. From the rather good survival during these years it might be expected that the commercial stock of plaice should increase, but in view of the strong fishing intensity we cannot expect any great improvement.

The number of 0-group flounder was above the normal especially in 1948 and some small improvement of the commercial stock during 1952 might be expected.

The survival of the turbot has, on the whole, been bad during the years 1946—48, and it must be expected that the commercial stock in 1952 will be of decreasing density.

##### Older Age-Groups.

Fishing with the eel-tog at Møen in April at 5 stations in 15—23 m. depth gave rather many plaice of the IV-group (year-class 1948,

see Table 8). From the investigations of the 0-group in 1948 this year-class was found to be richer than normal at Bornholm and at the eastern coast of Scania, but poorer than normal at the Seeland-Møen coast and at the southern coast of Scania. It seems that an immigration to the Møen region has taken place.

**Table 3. Number of Plaice, Flounder and Dab fished with the eel-tog per hour at Møen in April 1951.**

| Age-Group.... | I   | II  | III | IV | V | VI |
|---------------|-----|-----|-----|----|---|----|
| Plaice.....   | —   | —   | 1   | 7  | 1 | 1  |
| Flounder..... | —   | 0.4 | 0.4 | —  | — | —  |
| Dab.....      | 0.4 | 0.4 | 0.4 | —  | — | —  |

Fishing with trawl which was carried out from S.S. "Biologen" in August at a few stations at Møen and to the south of Scania showed rather many III-group dabs at a station at Møen, but very few flatfishes were found at the other stations. These were too few to give a true representation of the very sparse stock.

At Bornholm 9 stations with the trawl were taken at depths between 71 and 95 m. Average catches per hour of plaice were: 0.2, II-group and 0.2, IV-group; of flounder: 0.4, II-group and 0.2, III-group; and of dab: 0.2, II-group and 0.4, III-group, — a very poor stock.

AAGE J. C. JENSEN.

# Herring.

## INTRODUCTION

The following scientists have contributed to this report, which is the third one issued by the Herring Committee:

|                |                      |
|----------------|----------------------|
| Belgium .....  | M. Ch. GILIS         |
| Denmark .....  | Dr. A. J. C. JENSEN  |
| » .....        | Dr. Å. V. TÅNING     |
| France .....   | M. J. ANCELLIN       |
| Holland .....  | M. J. DE VEEN        |
| » .....        | M. L. K. BOEREMA     |
| Iceland .....  | Mr. ÁRNI FRÍÐRIKSSON |
| Scotland ..... | Mr. A. SAVILLE       |
| » .....        | Mr. G. MCPHERSON     |
| » .....        | Dr. H. WOOD          |
| » .....        | Mr. B. B. PARRISH    |
| » .....        | Mr. I. G. BAXTER     |

It is to be regretted that reports have not been received from all countries and that some of the contributions were submitted so late that they had to be sent directly to Copenhagen. It has therefore not been possible to make a general summary of contributions.

It appears, however, that intensive herring investigations are being carried out in most countries. The herring tagging scheme is still in progress, and more and more countries are taking up this kind of investigation; the methods are being improved and the number

of herrings being tagged is increasing from year to year. The taggings have not only brought us valuable knowledge on the migration of herring but have also served to give an idea of the order of the effect of the fisheries on some stocks. The results already obtained also make it clear that a revision of our ideas on "races", populations, tribes, etc. is required.

Attempts to standardize the form of written contributions to the herring report have not as yet been successful. It is understood, that the principal object of the publication of the "Annales" is to provide a general survey of the main features characterizing each particular year, or in other words, to compare that year with the normal. The inclusion of too many details will not only occupy too much valuable space and require too much expenditure, but will often cause the most important points to be hidden. It might be worth while, therefore, to make new attempts to standardize and simplify the contributions to the herring report and also those to any other reports for the Annales; this however can only be done with the cooperation of every contributor.

ÁRNI FRÍÐRIKSSON.



## REPORTS

## A. Atlantic Waters.

## COMMERCIAL FISH

## Iceland.

## The Icelandic North Coast Herring in 1951.

During July-August 26 samples (2600 herrings) were examined as to length, sex, stages of maturity, intestinal fat, number of vertebrae (VS), age and growth-type.

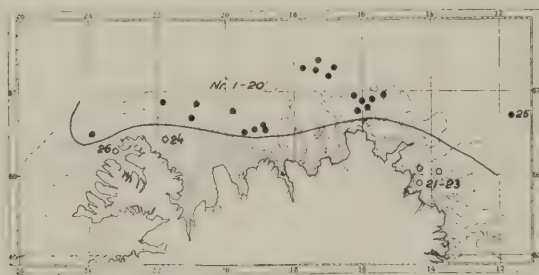


Figure 1. North coast herring 1951. Localities of sampling.

The origin of the samples is shown on the chart in Figure 1. An interesting feature is that the fishing took place mainly in offshore waters far from the coast and also mostly in localities new for Icelandic purse-seine vessels. There was a considerable amount of fishing in the ocean 100—200 miles east of Iceland, but the herring caught there were processed in the factories on the north-east and east coasts and we

Table 1. Size of North Coast Herring in 1951 (%).

| Length cm. | Samples |      |       |      |      | Total |
|------------|---------|------|-------|------|------|-------|
|            | 26      | 24   | 21—23 | 25   | 1—20 |       |
| 39.....    | —       | —    | —     | —    | 0.2  | 0.2   |
| 38.....    | —       | —    | —     | 2.0  | 2.3  | 1.9   |
| 37.....    | 1.0     | 4.0  | 5.3   | 2.0  | 13.4 | 11.2  |
| 36.....    | —       | 7.0  | 21.7  | 35.0 | 35.1 | 31.0  |
| 35.....    | 4.0     | 15.0 | 27.8  | 36.0 | 33.6 | 31.0  |
| 34.....    | 6.0     | 35.0 | 22.0  | 21.0 | 12.9 | 15.0  |
| 33.....    | 40.0    | 33.0 | 14.0  | 4.0  | 2.1  | 6.2   |
| 32.....    | 35.0    | 6.0  | 4.3   | —    | 0.2  | 2.3   |
| 31.....    | 13.0    | —    | 2.0   | —    | 0.2  | 0.9   |
| 30.....    | 1.0     | —    | 2.3   | —    | —    | 0.3   |
| 29.....    | —       | —    | 0.3   | —    | —    | —     |
| 28.....    | —       | —    | 0.3   | —    | —    | —     |
| Total....  | 100     | 100  | 100   | 100  | 100  | 100   |
| Number..   | 100     | 100  | 300   | 100  | 2000 | 2600  |
| Mean....   | 32.5    | 33.9 | 34.4  | 35.2 | 35.5 | 35.2  |

only got one sample from there (No. 25 on the chart).

When racial characters, age composition and the stage of maturity were considered, it became necessary to subdivide the material into 5 groups, as shown on the chart: 1) samples 1—20; 2) sample 25; 3) samples 21—23; 4) sample 24; 5) sample 26. The samples 1—20 constituted a natural unit closely similar to sample 25, while samples 21—23 were considerably different and samples 24 and 26 were quite different from the main bulk of the stock.

We will first examine the size of the fish as shown in Table 1. The average length of the total was 35.2 cm., or 1 mm. less than in the preceding year. This was however due to the influence of samples 24 and 26, and even partly of 21—23, in which younger fish predominated. The average length of the north coast herring proper (samples 1—20) was 35.5 cm. which was considerably greater than it was even in 1950 (Ann. Biol., VII, p. 123). It is also evident that the herring caught in coastal waters farthest to the west were much smaller than the remainder of the stock.

Table 2. Age of North Coast Herring in 1951 (%).

| Year-class              | Samples |      |       |      |      | Total |
|-------------------------|---------|------|-------|------|------|-------|
|                         | 26      | 24   | 21—23 | 25   | 1—20 |       |
| 3 1948                  | —       | —    | 2.9   | —    | —    | 0.4   |
| 4 1947                  | —       | —    | 3.7   | —    | 0.1  | 0.5   |
| 5 1946                  | 12.1    | 2.6  | 4.8   | 1.0  | 0.2  | 1.3   |
| 6 1945                  | 56.0    | 48.7 | 14.5  | 5.1  | 2.4  | 7.7   |
| 7 1944                  | 16.5    | 23.0 | 12.6  | 7.2  | 5.5  | 7.4   |
| 8 1943                  | 6.5     | 2.6  | 10.2  | 11.4 | 7.0  | 7.4   |
| 9 1942                  | 6.5     | 9.0  | 4.8   | 5.1  | 4.6  | 4.9   |
| 10 1941                 | —       | 3.8  | 6.2   | 4.1  | 4.2  | 4.2   |
| 11 1940                 | 1.2     | 3.8  | 7.3   | 14.4 | 7.2  | 7.2   |
| 12 1939                 | —       | —    | 3.3   | 6.2  | 7.7  | 6.5   |
| 13 1938                 | —       | —    | 7.3   | 8.2  | 13.4 | 11.9  |
| 14 1937                 | 1.2     | —    | 7.7   | 21.8 | 19.8 | 16.8  |
| 15 1936                 | —       | 1.3  | 4.1   | 3.1  | 5.2  | 4.6   |
| 16 1935                 | —       | 2.6  | 2.6   | 4.1  | 8.5  | 7.1   |
| 17 1934                 | —       | 2.6  | 7.3   | 6.2  | 10.8 | 9.4   |
| 18 1933                 | —       | —    | 0.7   | 2.1  | 2.2  | 1.8   |
| 19 1932                 | —       | —    | —     | —    | 0.9  | 0.7   |
| 20 1931                 | —       | —    | —     | —    | 0.2  | 0.2   |
| 21 1930                 | —       | —    | —     | —    | 0.1  | —     |
| Total....               | 100     | 100  | 100   | 100  | 100  | 100   |
| N <sub>g</sub> .....    | 9       | 22   | 28    | 3    | 264  | 326   |
| N <sub>g</sub> /total.. | 100     | 100  | 300   | 100  | 2000 | 2600  |

N<sub>g</sub> = Number with scales not fit for age reading.

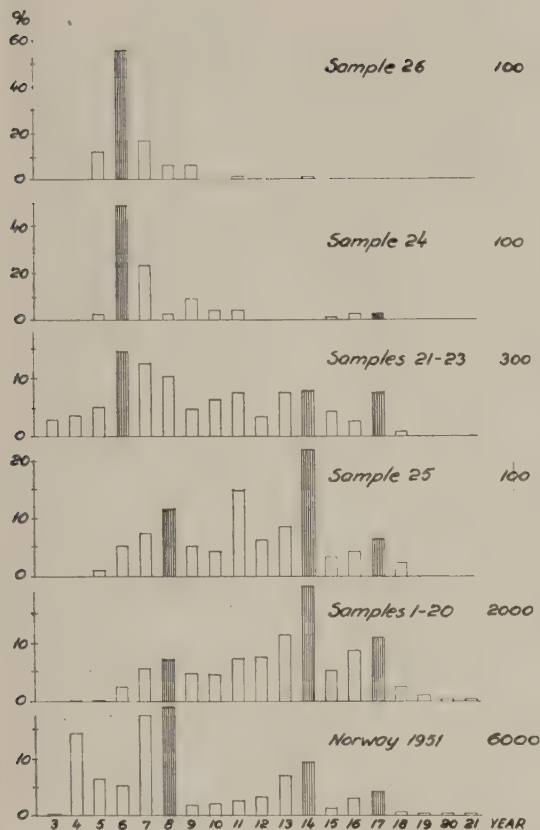


Figure 2. North coast herring 1951. Age distribution on different localities (see Fig. 1) and comparison with Norwegian large and spring herring of 1951. The figures on the right show the number of fish examined.

In Table 2 a corresponding survey is given of the age of the herring, and in Figure 2 the age composition is demonstrated by a diagram. The age composition explains the already mentioned difference in size. Commencing with the most western sample, No. 26, we find that an extremely strong dominant year-class, that from 1945, made up 56% of the total. There were three other broods which appeared to be relatively strong, viz. 1942, 1940 and 1937. Sample 24 was very similar to sample 26; the 1945 year-class made up 48.7% of the total and the 1942 year-class was clearly the secondary dominant with the broods from 1940 and 1934 also relatively strong. If we now consider the main stock (samples 1—20), it is evident that the absolutely predominant year-class was that from 1937, 14 years old, con-

stituting a fifth part or 19.8% of the stock; and that there were three relative dominants, the broods from 1934, 1940 and 1943 consisting of 17, 11 and 8-year-old herring which constituted 10.8, 7.2 and 7.0% of the stock respectively. Turning now to sample 25 we find that its age composition was very similar to that of the main stock (samples 1—20); there were the same predominating year-classes, with the only difference that the younger ones were relatively stronger and the oldest one considerably weaker. Finally the herring in coastal waters off the east coast (samples 21-23) represented an intermediate between the main stock (and also sample 25) on the one hand and herring from the western coastal catches on the other; the dominant broods from the main stock were, except for the youngest one (1943), also well represented here, but the absolute dominant from the west (1945) was also predominant here.

For purposes of comparison the age composition of the Norwegian spring and large herring in 1951 is shown (with the permission of Mr. FINN DEVOLD) at the bottom of Figure 2. This material comprised 600 fish. A glance at the figure is sufficient to reveal convincingly the similarities as regards age composition between the main Icelandic north coast stock and the Norwegian ones. As usual the younger year-

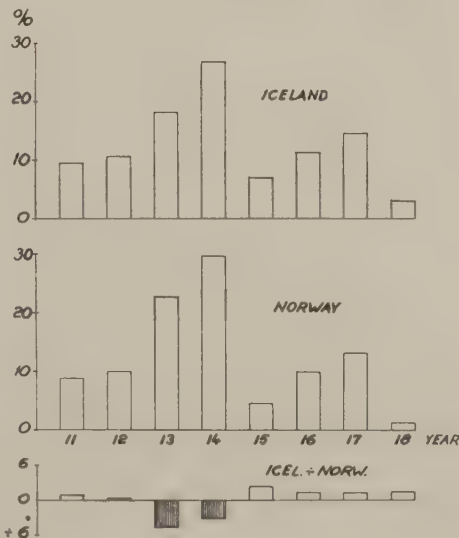


Figure 3. The relative strength of the oldest year-classes (11—18 years) at Iceland (samples 1—20) and Norway in 1951, and the deviations, Iceland—Norway (11 + 12 + ... 18 = 100 %).

classes were more pronounced at Norway, and the older ones at Iceland. It is usually only after reaching an age of about 10 years that the Norwegian spring and large herring begin to frequent Icelandic waters to any considerable extent. The almost perfect agreement as to the strength of the older year-classes (11–18 years) at Norway and Iceland can clearly be seen in Figure 3. Almost every detail was similar except, as already mentioned for a slight tendency towards higher age in Icelandic waters.

The age and size of the north coast herring in 1951 indicated that we were dealing with fish of two origins. The main stock (samples 1–20 and 25) was doubtless of Norwegian origin as has been shown by the comparison above. The samples 24 and 26 or at least the greatest part of them, must however be regarded as originating from local stocks; this is on account of the entirely different age composition (year-class 1945). The eastern coastal herring, as already mentioned, were a mixture of both. This division of the stock is also supported by the number of vertebrae, which turned out to be as follows:—

| Samples |                          |
|---------|--------------------------|
| 1—20    | $V_s = 57.110 \pm 0.015$ |
| 25      | $V_s = 57.110 \pm 0.056$ |
| 21—23   | $V_s = 57.080 \pm 0.035$ |
| 24      | $V_s = 57.020 \pm 0.060$ |
| 26      | $V_s = 56.940 \pm 0.058$ |

In Table 3 and the diagram in Figure 4, is given a survey of the percentage strengths of the different tribes. It appears that nearly 9% of the scales (219) were not suitable for race-determination. The total number of Atlanto-Scandinavian herring in the whole material amounted to 83%, of which 62.8% were of the northern Norway type and 20.2% were of the

**Table 3. The Tribes in the North Coast Herring calculated in Percentage for each Sample or Group of Samples.**

NN = North-Norway type; NS = South-Norway type; ISPR = Icelandic spring spawner; ISUM = Icelandic summer spawners;  $N_2$  = Number with scales not fit for type analyses.

| Samples     | NN   | NS   | ISPR | ISUM | Total | $N_2$ | Total |
|-------------|------|------|------|------|-------|-------|-------|
| 1—20 ...    | 72.3 | 21.9 | 5.6  | 0.2  | 100   | 165   | 2000  |
| 21—23 ...   | 38.7 | 16.2 | 45.1 | —    | 100   | 16    | 300   |
| 24 ...      | 5.2  | 5.2  | 89.6 | —    | 100   | 23    | 100   |
| 25 ...      | 55.6 | 28.3 | 16.1 | —    | 100   | 1     | 100   |
| 26 ...      | —    | —    | 19.7 | 80.3 | 100   | 14    | 100   |
| Total, .... | 62.8 | 20.2 | 14.0 | 3.0  | 100   | 219   | 2600  |

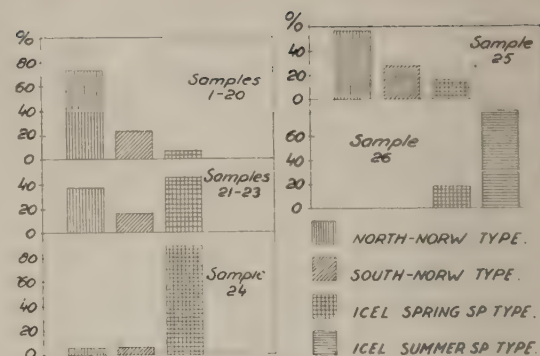


Figure 4. The relative strength of the tribes in different samples (%).

southern Norway type (see the bottom line of the table). There were 14% Icelandic spring spawners and 3% summer spawners. The reason for the relatively high percentages of the two last-named tribes is the inclusion of samples 24 and 26 which did not contain any considerable amount of the north coast herring proper; sample 24 contained mostly Icelandic spring spawners whereas summer spawners made up 80.3% of sample 26. Considering only the main stock and sample 25, the composition by tribes was as follows:—

| Samples                        | 1—20<br>% | 1—20 + 25<br>% |
|--------------------------------|-----------|----------------|
| Northern Norway type.....      | 72.3      | 71.5           |
| Southern Norway type.....      | 21.9      | 22.2           |
| Icelandic spring spawners..... | 5.6       | 6.1            |
| Icelandic summer spawners..... | 0.2       | 0.2            |

Atlanto-Scandinavian herrings constituted 94.2% in the first case and 93.7% in the second one. Summer spawning herring were practically absent.

The total number of vertebrae for each type and locality is given in Table 4. The material was not considered to be enough to allow a survey of the number of vertebrae in the different year-classes to be made. The total number of vertebrae for the whole material turned out to be  $57.099 \pm 0.013$ . From the table we note that the northern Norway tribe had a vertebral number of  $57.122 \pm 0.013$  in samples 1–20 and  $57.091 \pm 0.075$  in sample 25. The corresponding figures for the southern Norway tribe were  $57.075 \pm 0.035$  and  $57.250 \pm 0.119$ . The summer spawners had a low number of VS, as was to be expected, but the low figures relating to northern Norway and



southern Norway in sample 24 are surprising. Moreover there were very low numbers of vertebrae in the Icelandic spring spawners in samples 21–23 and 25, and even in sample 24. This might suggest that here we were really dealing with summer spawners, but there are good reasons against such an assumption. The stage of maturity was too advanced, 94.7% being in stage III and VIII in the samples 21–23, and 100% in sample 24. For comparison it must be emphasized that 99.3% of the main stock were of this degree of maturity (III and VIII), whereas there were 67.0% in stage VII in sample 26 which contained 80.3% summer spawners. The average amount of intestinal fat (scale 0–3) was found to be 1.2 for sample 24, 1.4 for samples 21–23, 1.4 for samples 1–20 and only 0.5 for sample 26. Finally there are the growth types of the scales.

Formerly the spawning period of the Icelandic spring spawners was considered to be from the middle of March to the end of April and that of the summer spawners from the middle of July to the end of August. But, according to records of “spawny” haddocks, the spawning off the western part of the south coast

for “spring” spawners with a low number of vertebrae, and it seems reasonable to assume that some spawning may take place throughout the entire period from March to September, even if there are two shorter periods of culmination.

During July–August 1951 3065 herrings were marked with internal tags off the north-east and north coasts. At Iceland the following 36 returns were recorded during 1951:–

| Tagged in  | Place of tagging |        |       | Total |
|------------|------------------|--------|-------|-------|
|            | Iceland          | Norway | Ocean |       |
| 1948.....  | 12               | —      | —     | 12    |
| 1949.....  | *                | 3      | —     | 3     |
| 1950.....  | 11               | 1      | 1     | 13    |
| 1951.....  | 7                | 1      | —     | 8     |
| Total..... | 30               | 5      | 1     | 36    |

\* No tagging made at Iceland this year.

Although the number of returns from Norway does not seem to be very imposing, being 5 only, it is worth noting that they represent approximately one tag per 100,000 hectolitre of processed herring, which is about the same frequency of tags per unit of catch as was found in Norway in the spring of 1951 (records from Norwegian taggings only). Another feature, worth mentioning, is that one of the Norwegian tags came from herring caught off the extreme western part of the north coast during the first half of July. Altogether 192 Icelandic tags have now been returned. 31 of them, however, came from Icelandic waters in the same season as the fish were liberated (21 in 1948, 3 in 1950 and 7 in 1951) and gave, therefore, no information on international migrations. Of the remaining 161 Icelandic tags, 80 were recorded from Icelandic and 81 from Norwegian factories. It is still too early to estimate the taxation of the Atlanto-Scandinavian herring stock by the fisheries, but it may be mentioned that during the winter of 1951–1952 13 Icelandic tags from the experiment of 1950 and 29 from 1951 were reported from Norway; this accounts for about 1% of the fish liberated in each experiment (1321 in 1950 and 3065 in 1951). It is also interesting to note that 10 herrings tagged in Iceland in the summer of 1948 were recaptured in Norway in 1952, having spent  $3\frac{1}{2}$  years in the sea.

The summer of 1951 was an extremely bad fishing season for herring off northern Iceland, the 7th in a consecutive series of bad years. It is probable that the occurrence of herring in

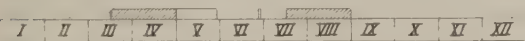


Figure 5. Spawning periods of herring at Iceland (Jan.-Dec.). The hatched fields refer to older sources, the white ones to investigations in 1950–1951.

took place as late as the end of May in 1950, and “spawny” haddock were found at the end of June in 1951 (see Figure 5). This extension of the spawning period might be responsible

**Table 4. The Total Number of Vertebrae (VS.) in the different Tribes of the North Coast Herring.**

| For explanation see the heading of Table 3. |                  |                  |                  |                  |
|---------------------------------------------|------------------|------------------|------------------|------------------|
| Samples                                     | NN               | NS               | ISPR             | ISUM             |
| 1—20.....                                   | 57.12<br>± 0.013 | 57.08<br>± 0.035 | 57.21<br>± 0.072 | 56.67<br>± 0.368 |
| 21—23.....                                  | 57.12<br>± 0.056 | 57.11<br>± 0.102 | 56.99<br>± 0.051 | —                |
| 24.....                                     | 56.75<br>± 0.260 | 56.75<br>± 0.260 | 57.01<br>± 0.067 | —                |
| 25.....                                     | 57.09<br>± 0.075 | 57.25<br>± 0.109 | 56.94<br>± 0.143 | —                |
| 26.....                                     | —                | —                | 57.35<br>± 0.172 | 56.84<br>± 0.067 |
| Total.....                                  | 57.11<br>± 0.017 | 57.08<br>± 0.031 | 57.08<br>± 0.035 | 56.83<br>± 0.065 |

Gr. Tot. = 57.10 ± 0.013.

these waters has never been as scanty as in this summer. The majority of the catches were taken on quite new fishing grounds in waters far offshore. The coastal waters were dominated by Atlantic water from the south, carrying young saithe, sandeels and even some herrings of local origin (samples 24 and 26). The bulk of the north coast stock (Atl.-Scand.) remained much farther out and great densities were reported east of the country. In this eastward region, next to the coast, there was some occurrence of local herring mixed up with the large stock (samples 21—23). These herring, which belonged to the Icelandic spring spawning type, were mostly young (see Table 2) and had perhaps been stationary and grown up in the east. It is quite certain, that if the fishing vessels had limited their effort to the old good grounds off the north coast there would hardly have been any yields at all, or at best they would have been much less than in any previous year.

ÁRNI FRÍÐRIKSSON.

#### North-East of the Faroe Islands.

##### Occurrence of Herring in June and about 1. December 1951.

During 1951 the occurrence of herring in the waters north and north-east of the Faroes was studied by the "Dana" in June (7. June to 1. July) and late in autumn (19. November to 13. December). The investigations were carried out as part of the general herring programme for the study of the Norwegian-Icelandic spring spawning herring, with special regard to the interests of Faroese and Danish fishermen in the area considered. The Bendix and Atlas echo-sounders were used along all routes covered. The hydrographic conditions were also followed on all routes, and the results are given in the North Western Area report by Mr. F. HERMANN (p. 23 et seq.).

Similar to June 1950 herring were found also in June 1951 scattered in spots and great shoals all over the area of mixed water, but in 1951 to a higher degree also in the East-Iceland arctic current; as during preceding years herring were practically absent in the warm Atlantic water. In June the herring were evidently more on the move than in 1950, probably migrating north. They were present in particular in a depth of 15 to 35 metres.

(Faroe herring boats followed the herring along the cold current north to the latitude of Langanes during the autumn—October included—and had rather good fishing). The hydrographic conditions differed somewhat in the years 1950 and 1951 (compare A. B. VII, 1950, pp. 14 and 15 with the 1951-report in this issue p. 24—25), cold water predominating to a somewhat higher degree 1951 than in 1950. Later in the year the inflow of Atlantic water was however strong, as observed during the autumn cruise.

In November-December the weather was very unfavourable but the echo-sounders made the research after herring possible. Herring were only met with (4. 5. December) in an area about  $64^{\circ}37' - 64^{\circ}29'$  N. Lat. and  $6^{\circ}45' - 7^{\circ}50'$  W. Long., but were present here in the "cold tongue" in enormous quantities. They were found in depths between ca. 10 and 150 metres, most abundantly in the upper water layers; the temperature was about  $3.8^{\circ}\text{C}$ . from the surface to a depth of about 50 metres. In temperatures of  $6^{\circ}$  or more herring were absent. The Norwegian research vessel "G. O. Sars" could later on confirm the observation and follow the herring to the Norwegian coast. Drift-bottles liberated in the area where herring occurred were reported 84 days or more on the Norwegian west-coast in the herring spawning area.

Å. VEDEL TÅNING.

#### Norwegian Sea.

A sample of 140 herring caught by floating trawl—at Kråkenes,  $62^{\circ}03'$  N. Lat.— $4^{\circ}59'$  E. Long. by a Danish cutter on 1. March 1951—consisted mostly of mature and spawning fish, 71% of maturity stage V and 21% of stage VI, 1 fish was spent and 8% recovering spents. They were 31—38 cm. long.

The numbers of rings varied from 6 to 14. Only three 6- and 7-ringed fish were found, 10% were 8-ringed. About two thirds had about 10 rings but since it is difficult to count the number of rings at the edge of the scale, it is difficult to assess the share of the individual year-classes 1939, 1940 or 1941.

The racial characters of these Norwegian winter spawners ("vårsild") were: V.S., 57.27 (139); V.P., 24.43; K<sub>2</sub>, 14.23 (139).

AAGE J. C. JENSEN.

## B. North Sea and Adjacent Waters.

### YOUNG STAGES

#### Autumn-spawned Herring Larvae in the northern North Sea.

Scottish research vessels in 1951 carried out a series of cruises in the area bounded on the north by the  $60^{\circ}$  N. latitude, on the south by  $56^{\circ}$  N. latitude and on the east by  $2^{\circ}$  E. longitude, to investigate the distribution and abundance of autumn-spawned herring larvae. This area was surveyed during the following periods, 26. July—4. August, 20.—29. August, 5.—18. September, 5.—18. October, and 29. October—11. November. Additional cruises surveying the Moray Firth and the herring grounds off the Aberdeenshire coast were carried out during August. The utilisation of these data is rather handicapped by the fact that, largely due to bad weather, in none of the cruises was the area completely surveyed.

In 1951 hatching previous to the second week of August was on a negligible scale; the cruises in July and the beginning of August failed to locate any herring larvae. Newly hatched larvae thereafter occurred in the samples up to the first week of October when hatching apparently ceased. Spawning centres, as located by centres of density of larvae up to 8 mm. in size, were very localised. They occurred in August ca. 15 miles NE. of Kinnaird Head, on the eastern edge of Smith Bank and ca. 5 miles SE. of Rattray Head; in September over the western edge of Turbot Bank and on the eastern edge of Pappa Bank; and again in October over Turbot Bank. In agreement with CLARK (1933) these areas all lie within the forty-fathom contour but these results suggest that in individual years spawning may be much more localised within this area than CLARK's composite picture would suggest.

An investigation of the growth characteristics of herring larvae based on these data confirmed that in these, as in most fish larvae which have been investigated, growth is exponential—at least up to a size of 20 mm. The increase per day in the logarithm of the length was 0.0055. This growth is only about one third of that found by MARSHALL, NICHOLLS and ORR (1937) for spring-spawned herring

larvae in the Clyde, but is in substantial agreement with the growth-rate found for autumn spawned larvae in the North Sea by WALLACE (1924), BÜCKMANN (1950), and deduced from CLARK'S (1933) data.

The subsequent drift of the larvae from the spawning centres shows a general tendency to radiate outwards to the south and east. As regards the eastern drift, however, there is no indication of a shift of the centres of density in this direction out of the area but merely of a dispersion of the fringe of the distribution. The larvae spawned in the Pappa Bank region would seem to have drifted between successive cruises across the outer Moray Firth to impinge on the Aberdeenshire coast; whilst those spawned off the Aberdeenshire coast drifted southwards to the Firth of Forth region and perhaps even farther south.

As there are no truly comparable data from previous years, no useful quantitative statement concerning the abundance of the 1951 herring brood can be made at this stage.

ALAN SAVILLE.

#### 0- and I-group. Scotland 1950-1951.

Sampling of young herring in east Scottish coastal waters has continued in 1951. Although it has not been possible to work up all the samples taken by research vessels (see Table 5) the material examined so far indicates that herring of spring origin were present in strength for the first time since the war. The herring examined racially were all 0-group and only in two catches in March 1951 does the size range and mean length indicate the presence of I-group herring in any quantity.

One of these catches was made in the Inverness Firth, the herring measuring from 9 to 25 cm., the other one was made in the Dornoch Firth, 1913 herring of lengths from 11 to 20 cm. mean length 15.4 cm.

The catch per hour by "Kathleen" was greater than during the previous winter (Ann. Biol., Vol. VII, p. 128).

| Period              | Hrs. Fishing | Total Catch  | Catch per Hr. |
|---------------------|--------------|--------------|---------------|
| Nov. 1950-Nov. 1951 | 55½          | 3067 herring | 55.3          |



The racial characters of the I-group herring caught by commercial vessels show that, as in the previous year, autumn spawners formed the bulk of the samples and that the small proportion of spring spawners was less than in 1950 (Ann. Biol. Vol. VII, p. 128).

**Table 5. Length and Racial Characters of 0- and I-Group Herring caught by R. V. "Kathleen" and "Explorer" (0-Gr.) and by Commercial Vessels (I-Gr.) in Inshore Waters of the Scottish East Coast.**

| (Numbers in brackets).                      |             |             |                  |          |  |
|---------------------------------------------|-------------|-------------|------------------|----------|--|
| Locality                                    | Month, Year | Range, cm.  | Mean Length, cm. | Vert. S. |  |
| Firth of Forth ... Jan. 1951                | 8—18        | 11.5 (4338) | 56.38 (101)      |          |  |
| — — — — — Mar. —                            | 9—17        | 11.9 (812)  | 56.73 (103)      |          |  |
| St. Andrew's Bay Apr. —                     | 8—15        | 10.5 (233)  | 56.68 (103)      |          |  |
| Lunan Bay .... Jan. —                       | 12—17       | 13.7 (405)  | 56.64 (405)      |          |  |
| — — — — — Mar. —                            | 6—12        | 9.9 (290)   | 56.60 ( 98)      |          |  |
| Aberdeen Bay ... Jan. —                     | 10—18       | 13.8 ( 91)  | 56.56 (126)      |          |  |
| — — — — — Feb. —                            | 10—15       | 12.2 (222)  | 56.83 (102)      |          |  |
| — — — — — Apr. —                            | 5—15        | 11.5 ( 40)  | 56.80 ( 35)      |          |  |
| Inverness Firth ... Nov. 1950               | 10—15       | 11.7 (309)  | 56.83 ( 88)      |          |  |
| Dornoch Firth ... Nov. —                    | 10—14       | 12.1 ( 60)  | 57.07 ( 57)      |          |  |
| I-Group                                     |             |             |                  |          |  |
| Firth of Forth <sup>2)</sup> ... Jan. 1951  | 16—25       | 22.4 (213)  | 56.48 (212)      |          |  |
| — — — — — Feb. —                            | 16—26       | 23.2 (160)  | 56.46 (157)      |          |  |
| Inverness Firth <sup>3)</sup> ... Nov. 1950 | 16—24       | 21.3 (158)  | 56.46 (156)      |          |  |
| — — — — — Dec. —                            | 16—24       | 21.3 (225)  | 56.42 (220)      |          |  |

<sup>1)</sup> Caught by trawl

<sup>2)</sup> Caught by ring net

<sup>3)</sup> Caught by drift-net.

In addition to the catches mentioned in Table 5, seven catches, consisting almost exclusively of 0-group herring, were also measured. One was taken in January in St. Andrews Bay, seven were made in March 1951 in inshore waters between this bay and Aberdeen Bay and one in Aberdeen Bay in September 1951. The length of the fish ranged from 5—17 cm., the mean length varying between 9.1 and 12.9 cm. (2514 fish were measured).

G. McPHERSON.

### Young Herring at the "Bloden" Ground — Clay Deep.

Three samples from 25. February, 2. August, and 21. September of herring fished at the "Bloden" ground ca. 60—100 sm. W. and W. × N. of Esbjerg were investigated and gave the following figures as to length, age, and racial characters:

| Mat.       | Length Distribution, cm. |    |    |       |    |    |       |    |    |    |    |  |
|------------|--------------------------|----|----|-------|----|----|-------|----|----|----|----|--|
|            | 13/14                    | 15 | 16 | 17/18 | 19 | 20 | 21,22 | 23 | 24 | 25 | 26 |  |
| Febr. I-II | 0.3                      | 1  | 47 | 36    | 9  | 6  | 0.3   |    |    |    |    |  |
| Aug. I-IV  | —                        | 3  | 30 | 41    | 24 | 2  | —     |    |    |    |    |  |
| Sept. I-II | —                        | —  | 16 | 41    | 40 | 3  | —     |    |    |    |    |  |
| — III-VI   | —                        | —  | —  | 3     | 61 | 31 | 5     |    |    |    |    |  |
| — I-VI     | —                        | —  | 9  | 24    | 49 | 16 | 2     |    |    |    |    |  |

| Age Composition (%). |    |   |   |     |   |
|----------------------|----|---|---|-----|---|
| Rings:               | 1  | 2 | 3 | 4   | 5 |
| Febr. 90             | 8  | 2 | — | 0.3 |   |
| Aug. 80              | 20 | — | — | —   |   |
| Sept. 47             | 47 | 4 | 2 | —   |   |

| Racial Characters. |             |       |                |  |
|--------------------|-------------|-------|----------------|--|
| Mat.               | K. S.       | V. P. | K <sub>2</sub> |  |
| Febr. .... I—II    | 56.45 (172) | 23.77 | 14.78 (169)    |  |
| Aug. .... I—IV     | 56.61 (180) | 23.84 | 14.85 (179)    |  |
| Sept. .... I—III   | 56.54 (126) | 23.72 | 14.88 (122)    |  |
| — .... IV—VI       | 56.56 ( 54) | 23.68 | 14.96 ( 53)    |  |

The February sample consisted of autumn spawners from the north-western North Sea, mostly 1-ringed, i.e., year-class 1948; their mean length was 19.1 cm. In August herring of this year-class amounted to not more than 20% of the total catch; they had grown to a mean length of 22.0 cm. which, presumably, must be a little less than the actual growth. Their racial characters were in August: V.S., 56.53 (36); V.P., 23.81; K<sub>2</sub>, 15.03 (36), which (in view of the small numbers) corresponds with those of the same year-class in February.

In addition to these herrings a new stock of 1-ringed had appeared on the ground, but according to their racial characters they were Downs herring. In the September sample this race-group predominated even more, and the stock had now been augmented also by herrings of maturity V (and some few with running milt and roe), but obviously of the same race.

The yield of the Danish herring fishery on the "Bloden" ground and the adjacent Clay Deep amounted to 31 mill. kg. including a small amount of whiting. It is of course a matter of outstanding practical importance if the occurrence of a very large amount of young herring on this fishing ground is a normal feature. The stock seems to have shifted rather much since the fishery began in July 1950, when a Danish cutter had accidentally found the dense stock of young herring, and this may indicate that this ground is not regularly a residence of the young, but on the other hand we know that many of the 0- and I-group fish each year use to occur in great quantities in the German Bight and off the south Jutland

coast, and it may be expected that many of them pass the "Bløden" ground and the Clay Deep when they leave the coastal areas. The occurrence of herring may vary according to natural conditions, especially for feeding, and the density may be influenced by the strength of the year-classes, and it is possible that a strong 1949 year-class of North Sea autumn spawners has contributed to the large fishing. The mean weight of the herring caught was ca. 60 g. and the total number caught amounted to ca. 400 mill. kg. This is a comparatively small number in comparison with the total commercial catch of North Sea autumn herring.

The fat content of the 17–19 cm. long, immature herring was in February about 6%, in those of 20–24 cm. length 8–9%, ca. 20% in August and ca. 17% in September.

AAGE J. C. JENSEN.

## COMMERCIAL FISH

### Scottish Fisheries.

Investigations of the stocks of herring fished by Scottish commercial drifters, ring-netters and trawlers was continued throughout 1951 on an intensified scale. Samples were obtained for age and racial analysis from each of the main drift-net fisheries off the Scottish east and west coasts, and from the fisheries on the Coral Bank and at Fladen. These investigations were accompanied by extensive tagging experiments from commercial fishing vessels on the east and west coast grounds.

The collection of detailed daily landing statistics was commenced in 1951 at the main drift-net ports. These provided data of the distribution of effort and catch density from day to day throughout the fishing season, and are being used in investigations of the population dynamics and biology of the separate stocks.

#### East Coast and Shetland Fisheries.

The fisheries from the North Sea ports followed the same general course as in previous years, (Wood 1950). A restricted drift-net fishery in the Coral Bank region in March and April preceded the major fisheries from Fraserburgh, Peterhead and Lerwick during the period May to mid-September. The trawl fishery at Fladen was conducted by a small num-

ber of British vessels during the months July to November.

The total statistics of yield and effort for the main drift-net fisheries and the Fladen trawl fishery are tabulated below together with the corresponding data for 1950.

Table 6. East Coast Herring Landings.

|              | Landings<br>(crans) |        | Arrivals     |      | Av. landing per<br>arrival (crans) |       |
|--------------|---------------------|--------|--------------|------|------------------------------------|-------|
|              | 1950                | 1951   | 1950         | 1951 | 1950                               | 1951  |
| Fraserburgh  | 70,478              | 95,073 | 4913         | 7907 | 14.3                               | 12.0  |
| Peterhead... | 27,922              | 42,581 | 2164         | 3081 | 12.9                               | 13.8  |
| Lerwick...   | 53,110              | 31,463 | 3361         | 1916 | 15.8                               | 16.4  |
|              |                     |        | Hrs. fishing |      | Landings per 100<br>hours (crans)  |       |
| Fladen...    | 10,375              | 16,425 | 6123         | 7111 | 169.4                              | 231.0 |

Total effort and yield at the Fraserburgh and Peterhead fisheries were substantially higher and at Lerwick substantially lower in 1951 than in the previous year, but the catches per unit of effort remained at approximately the same level.

The statistics of the drift-net fisheries are presented in greater detail in Charts 1 to 10. Charts 1 to 5 give the number of arrivals and Charts 6 to 10 the catch per arrival at Fraserburgh, Peterhead, and Lerwick from each of a series of squares (10' longitude by 5' latitude) into which the fishing area has been subdivided in each of the months May to September. The statistics of "catch per arrival" have been calculated on the basis of a standard number of drift-nets per vessel of 100 nets so as to make them as comparable as possible with the mean catch data of the Dutch herring drift-net fishery charted in previous volumes, and the intervals of crans per arrival chosen in compiling the charts are made equivalent to the intervals of kantjes per shot used for the Dutch records.

These charts show the monthly trends in the distribution of fishing effort and of available herring density during the summer fisheries.

#### Length, Age and Racial Composition of Samples.

##### Coral Bank.

Herring were sampled from the landings of drifters working on the Coral Bank during April and May. The length, age, maturity and vertebral count data obtained from these samples are given in Table 7.

# Number of Arrivals.



Charts 1—5. May

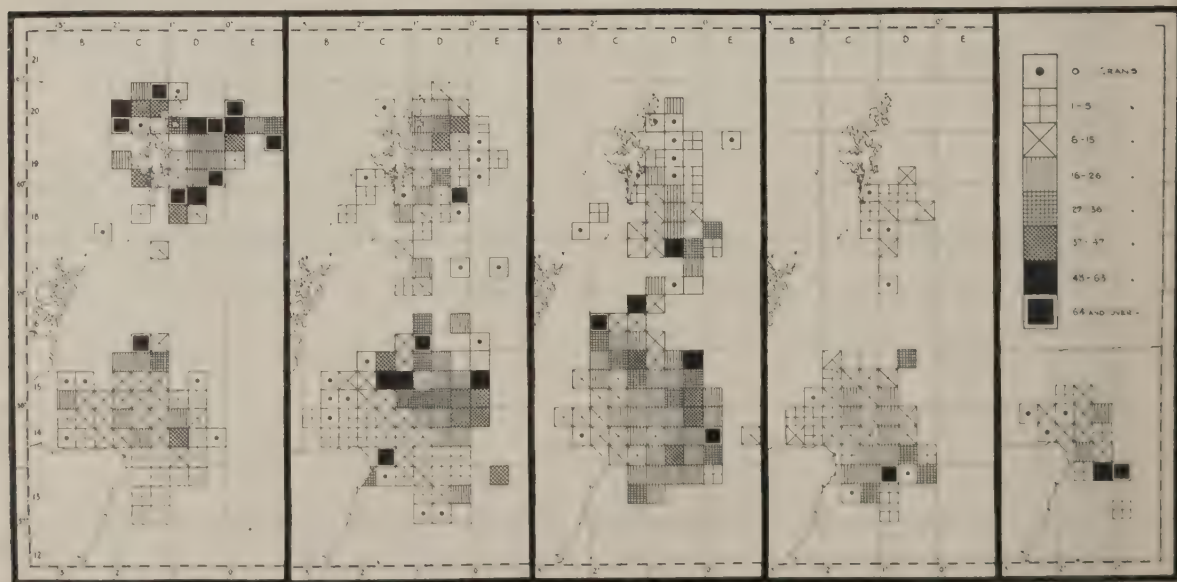
June

July

August

September

# Catch.



Charts 6—10. May

June

July

August

September



**Table 7. Length, Age and Racial Composition of Coral Bank Samples.**

| Length (cm.)                |     |      |      |       |       |       |      |      |                |     |     |
|-----------------------------|-----|------|------|-------|-------|-------|------|------|----------------|-----|-----|
| No. per<br>mille            | 24  | 25   | 26   | 27    | 28    | 29    | 30   | 31   | Mean<br>Length |     | No. |
|                             | 28  | 23.7 | 92.2 | 194.1 | 356.1 | 266.8 | 55.9 | 8.4  | 27.9           |     | 716 |
| Age (No. of winter rings)   |     |      |      |       |       |       |      |      |                |     |     |
| % Age<br>composition        | 2   | 3    | 4    | 5     | 6     | 7     | 8    | 9    | 10             | 10  | No. |
|                             | 0.3 | 3.1  | 13.5 | 12.9  | 12.1  | 13.9  | 19.5 | 13.1 | 8.4            | 3.2 | 716 |
| Maturities (all age-groups) |     |      |      |       |       |       |      |      |                |     |     |
| % maturity                  | I   | II   | III  | IV    | V     | VI    | VII  |      |                |     |     |
|                             | 2.5 | 14.0 | —    | 0.1   | —     | —     | 82.5 |      |                |     |     |
| Vert. S. (all age-groups)   |     |      |      |       |       |       |      |      |                |     |     |
| No. of vertebrae            | 55  | 56   | 57   | 58    | 59    | Mean  |      |      |                |     |     |
|                             | 40  | 298  | 328  | 40    | 3     | 56.33 |      |      |                |     |     |

The stock in the Coral Bank region consisted mostly of relatively old spent autumn spawned herring, with 8-ringers predominating. These results agree closely with those obtained in previous years (Wood 1950), and assume a special significance when compared with the composition of the Shetland, late north-east Scottish coast and Fladen fisheries.

#### North-east Coast and Shetlands.

The length and age compositions of the herring sampled at Fraserburgh, Peterhead and Lerwick in each month during the course of the drift-net fisheries are given in Figure 6,

and the maturity and Vert. S. material is presented in Table 8A and B.

The length frequencies and age composition data presented in Figure 6 reveal a change in stock composition off the north-east coast towards the end of the fishing season. In May, June and July the fishable population consisted mainly of herring between 3—6 years of age of maturity stages II, III and VII, but during August and September there was a marked influx of older, larger spawners of maturities IV to VI. This change is the same as that recorded in previous years (Wood 1950), but at a slightly later date. The 4-ringers (autumn spawned 1947 brood, mean vertebral count 56.45) were conspicuous in the catches in the first phase, although less so than as 3-ringers in 1950 but again they fell off in abundance in the second phase, thus suggesting their spawning ground to lie elsewhere (Wood 1950). Spring spawners do not appear to have been prominent in the fishable stocks in this area throughout the duration of the fisheries.

Herring with 4, 6 and 8 scale rings predominated in the Shetland stock throughout the main fishing months May to July. The appearance of the two older age-groups in the north-east coast fishery and at Fladen (see later) in August and September points to a movement of the older age-groups from the east-Shetland area to these grounds. This is also supported by results of tagging experiments carried out

**Table 8. Maturity and Racial Characters (all Age-Groups).**

| A. Percentage Maturity (all Age-Groups).       |             |             |             |             |             |             |             |             |             |             |             |             |             |             |  |
|------------------------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--|
| Maturity Stage                                 | Fraserburgh |             |             |             |             | Peterhead   |             |             |             |             | Lerwick     |             |             |             |  |
|                                                | M.          | J.          | Jy.         | A.          | S.          | M.          | J.          | Jy.         | A.          | S.          | M.          | J.          | Jy.         | A.          |  |
| I.....                                         | 7.8         | 15.8        | 9.4         | 5.5         | 0.7         | 7.9         | 22.2        | 6.4         | 2.1         | 0.5         | 6.0         | 16.9        | 10.1        | 8.9         |  |
| II.....                                        | 17.4        | <b>46.3</b> | <b>38.4</b> | 7.7         | 0.7         | 12.8        | <b>43.1</b> | <b>50.1</b> | 5.3         | 1.0         | 21.6        | <b>54.4</b> | <b>33.5</b> | <b>33.3</b> |  |
| III.....                                       | —           | 2.2         | <b>23.6</b> | 10.9        | 0.7         | —           | 0.9         | 16.2        | 6.0         | —           | 0.3         | 5.4         | <b>27.3</b> | 17.8        |  |
| IV.....                                        | —           | 0.5         | 13.0        | <b>29.9</b> | 10.7        | —           | 0.2         | 14.3        | <b>31.1</b> | 6.1         | —           | 0.9         | 12.3        | <b>28.9</b> |  |
| V.....                                         | —           | 0.2         | 6.0         | <b>35.6</b> | <b>46.8</b> | —           | 0.1         | 6.4         | <b>34.6</b> | <b>34.3</b> | —           | 0.2         | 3.7         | 6.7         |  |
| VI.....                                        | —           | —           | —           | 4.0         | <b>31.1</b> | —           | —           | 0.7         | 12.0        | <b>36.4</b> | —           | —           | 1.2         | —           |  |
| VII.....                                       | <b>74.8</b> | <b>35.0</b> | 9.6         | 6.4         | 9.3         | <b>79.3</b> | <b>33.5</b> | 6.0         | 8.9         | 21.7        | <b>72.1</b> | <b>22.1</b> | 11.9        | 4.4         |  |
| No.....                                        | 839         | 1084        | 1027        | 1140        | 299         | 632         | 1056        | 1007        | 1114        | 198         | 588         | 974         | 962         | 45          |  |
| B. Vert. S. (Actual Numbers - all Age-Groups). |             |             |             |             |             |             |             |             |             |             |             |             |             |             |  |
| No. of Vertebrae                               |             |             |             |             |             |             |             |             |             |             |             |             |             |             |  |
| 54.....                                        | —           | 2           | 8           | 1           | —           | —           | 2           | —           | —           | —           | 1           | —           | —           | —           |  |
| 55.....                                        | 19          | 50          | 97          | 66          | 26          | 10          | 47          | 36          | 39          | 15          | 12          | 21          | 19          | 1           |  |
| 56.....                                        | 260         | 461         | 433         | 533         | 144         | 184         | 439         | 210         | 414         | 81          | 170         | 273         | 173         | 16          |  |
| 57.....                                        | 266         | 509         | 389         | 469         | 116         | 180         | 494         | 220         | 383         | 41          | 209         | 313         | 257         | 34          |  |
| 58.....                                        | 37          | 41          | 72          | 55          | 10          | 18          | 53          | 41          | 64          | 5           | 41          | 62          | 61          | 4           |  |
| 59.....                                        | —           | 1           | 1           | 3           | —           | —           | 1           | 1           | 1           | —           | —           | 4           | 3           | —           |  |
| Mean.....                                      | 56.55       | 56.51       | 56.42       | 56.46       | 56.37       | 56.53       | 56.53       | 56.53       | 56.53       | 56.25       | 56.64       | 56.64       | 56.72       | 56.69       |  |
| No.....                                        | 582         | 1064        | 1000        | 1127        | 296         | 392         | 1036        | 508         | 901         | 142         | 433         | 673         | 513         | 45          |  |

M. = May, J. = June, Jy. = July, A. = August, S. = September.

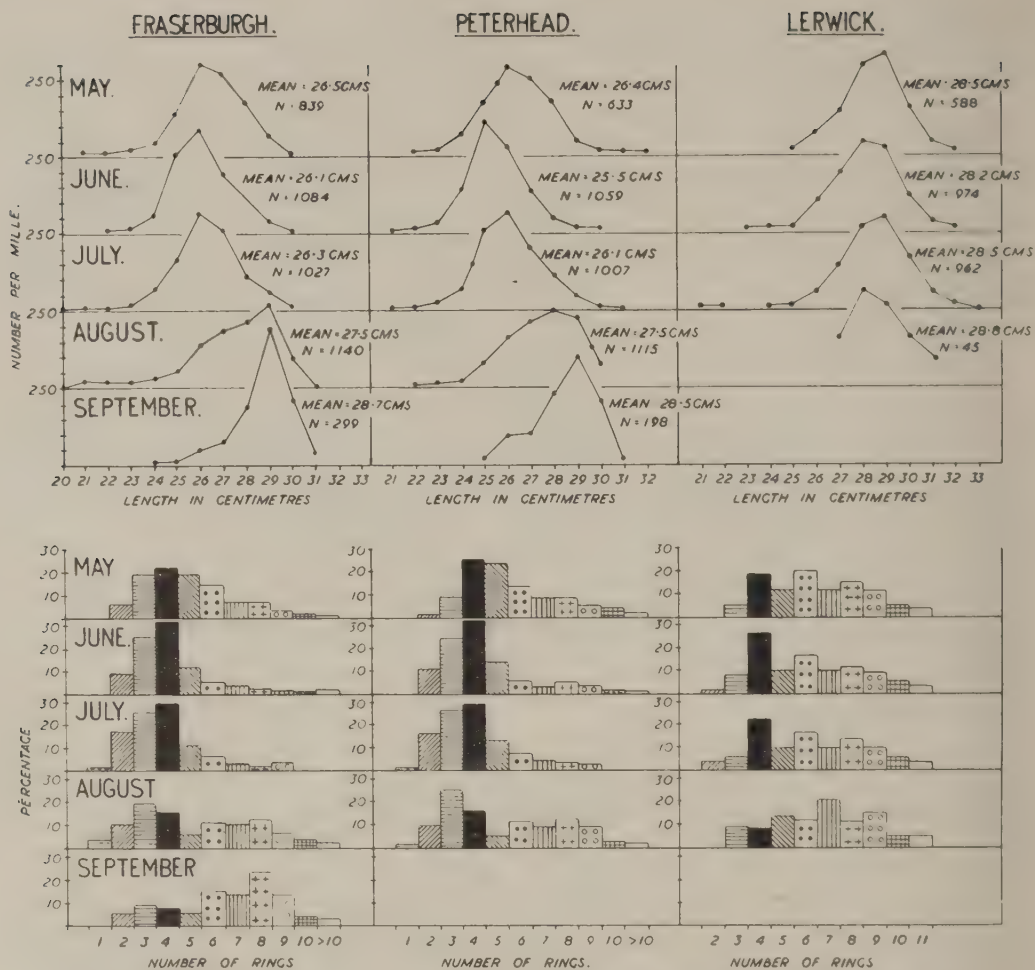


Figure 6. Length and age composition of north-east coast and Shetland drift-net herring samples. May-September, 1951. (Length frequencies unsmoothed.)

during the past three years. The racial data suggest that the Shetland shoals contained a greater proportion of spring spawned herring than did those fished off the north-east coast. This is shown particularly by the mean vertebral counts (56.93, Shetland; 56.45, north-east coast) of the 4-ringers which predominated in both areas. This difference is being investigated further from otolith material collected from the two areas.

#### Fladen.

Length, age and racial data were collected from the Fladen Ground during the period July

to November during the course of research vessel trawling surveys with a herring trawl. The length and age compositions of these samples are given in Figure 7 and the maturity and Vert. S. data are presented in Tables 9 and 10.

These data show approximately constant stock composition on the Fladen Ground throughout July, August, September and October, with fish of medium ages (5 to 10 rings) at maturity stages II to V predominating. At the end of October young herring of maturity stage I joined the stock of older spent fish (9–13 rings). The maturity and racial data show the July to September samples to be

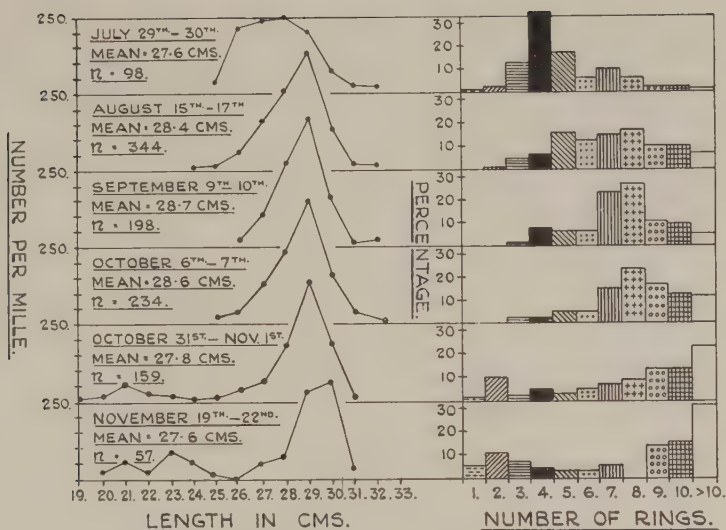


Figure 7. Length and age composition of Fladen herring trawl samples. July-November, 1951. (Length frequencies unsmoothed.)

### Maturity and Racial Characters (all Age-Groups).

Table 9. Percentage Maturity.

| Maturity Stage       | I           | II          | III         | IV          | V           | VI  | VII         | Num-<br>ber | 54 | 55 | 56  | 57  | 58 | 59 | Mean  |
|----------------------|-------------|-------------|-------------|-------------|-------------|-----|-------------|-------------|----|----|-----|-----|----|----|-------|
| Sampling Period:     |             |             |             |             |             |     |             |             |    |    |     |     |    |    |       |
| 29.—30. July .....   | 2.0         | <b>35.7</b> | <b>22.4</b> | 17.3        | <b>20.4</b> | —   | 2.0         | 98          | —  | 1  | 54  | 35  | 6  | —  | 56.48 |
| 15.—17. August ..... | 3.2         | 7.6         | 18.6        | <b>39.0</b> | <b>30.8</b> | 0.9 | —           | 344         | 1  | 15 | 146 | 146 | 23 | 1  | 56.54 |
| 9.—10. September ..  | 1.0         | 6.1         | 16.8        | <b>24.9</b> | <b>39.1</b> | 2.5 | 9.6         | 198         | —  | 12 | 64  | 76  | 11 | —  | 56.53 |
| 6.—7. October .....  | 0.4         | 5.1         | 10.3        | 15.8        | 1.3         | —   | <b>67.1</b> | 234         | —  | 9  | 95  | 111 | 7  | 1  | 56.53 |
| 31. Oct.—1. November | <b>13.2</b> | 6.9         | 0.6         | 1.9         | —           | 1.3 | <b>76.1</b> | 159         | —  | 8  | 64  | 80  | 5  | —  | 56.52 |
| 19.—22. November ..  | <b>22.6</b> | 1.9         | —           | 1.9         | —           | —   | <b>73.6</b> | 57          | —  | 4  | 26  | 21  | 2  | —  | 56.40 |

Table 10. Vert. S.

predominantly late autumn spawners and the young specimens in the later period to be mostly of autumn spawned origin. The mean vertebral counts of the 1-ring fish were considerably smaller than those recorded from trawl samples from the Fladen Ground in 1950 (Wood 1950).

#### Firth of Forth.

Sampling of the "halflin" fishery in the upper reaches of the Firth of Forth was carried out in the period January to March 1951. These herring consisting of one and two-year-old fish were shown from the vertebral count data to be of predominantly autumn spawning origin. There was no evidence of a return to the Firth of substantial quantities of spring spawning herring.

#### West Coast.

In 1951 scientific investigations were begun on the fishery which operates along the north-

west coast of Scotland. From the statistics it will be seen that this fishery is of considerable economic importance. Herring fishing in this area is conducted almost continuously throughout the year; there are however three main periods of activity; in the spring, summer and winter. The fishing grounds can be divided into two areas, North and South Minch. The catches are obtained by two different types of gear; some of the fishermen are equipped with drift-nets, others use ring-nets. Table 11 below gives the total yield and effort for both drift-

Table 11. West Coast Herring Landings.

|               | Total landing<br>crans |         | Drift-Net |       | Landing<br>per arrival |      |
|---------------|------------------------|---------|-----------|-------|------------------------|------|
|               | 1950                   | 1951    | Arrivals  |       | 1950                   | 1951 |
| N. Minch. . . | 106,221                | 101,171 | 9,274     | 7,200 | 11.5                   | 14.1 |
| S. Minch. . . | 8,733                  | 23,056  | 188       | 773   | 46.5                   | 29.8 |
|               |                        |         | Ring-Net  |       |                        |      |
|               |                        |         | Arrivals  |       | 1950                   | 1951 |
| N. Minch. . . | 35,605                 | 28,077  | 1,006     | 953   | 35.3                   | 29.5 |
| S. Minch. . . | 52,234                 | 48,818  | 1,773     | 1,982 | 29.4                   | 24.6 |



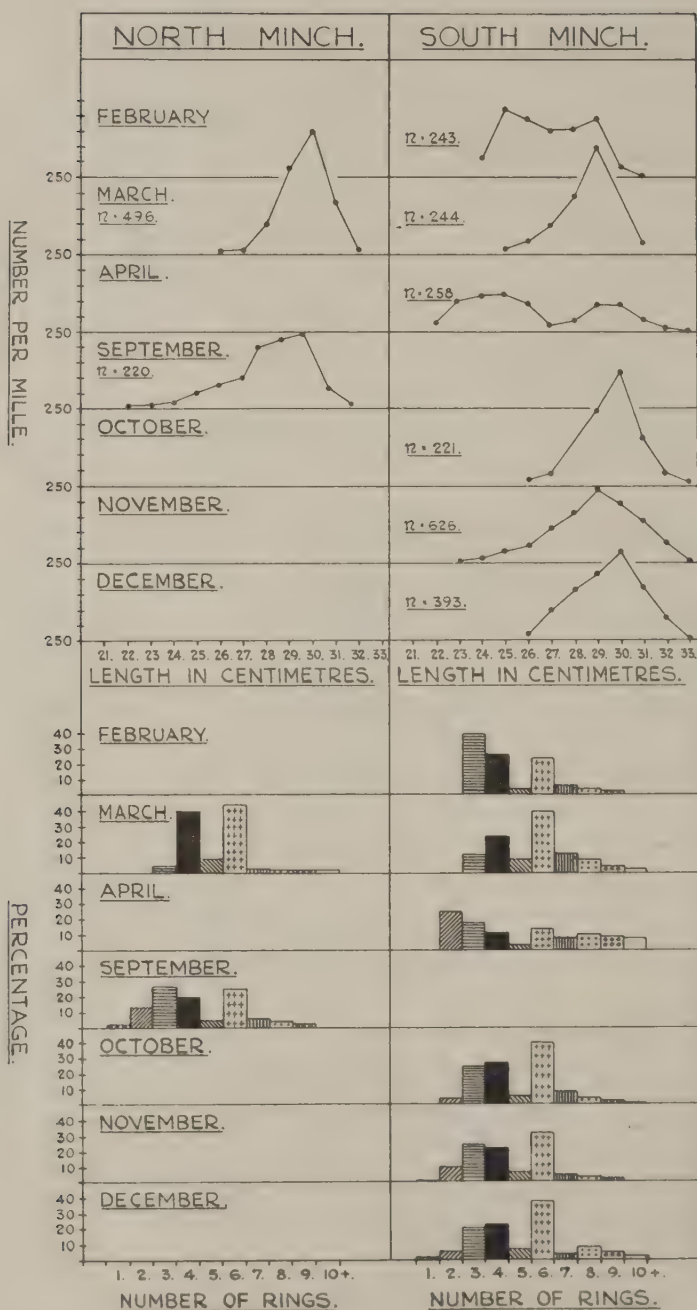


Figure 8. Length and age composition of west coast herring samples.  
 (North Minch are drift-net samples, the South Minch are ring-net samples).

and ring-net catches for 1950 and 1951 in the North and South Minch.

The North Minch is economically more important than the South. The total yield from the North Minch in 1951 was slightly lower than the 1950 figure, the opposite is the case however for the South Minch landings. In the North Minch, catches are obtained mainly by drift-nets, but the ring-net is used extensively on South Minch grounds.

A limited programme of sampling was carried out during the year. Samples were obtained from the commercial fishery in the spring, autumn and winter. No sampling was carried out in the summer owing to the intensive programme of sampling which took place on the east coast at that time.

**Table 12. Maturity and Vert. S. Composition of North and South Minch Samples.**

**Maturities Percentage**

**North Minch.**

|           | I  | II | III | IV  | V   | VI          | VII         |
|-----------|----|----|-----|-----|-----|-------------|-------------|
| March.... | 0  | 0  | 1.0 | 7.7 | 8.7 | <b>70.8</b> | <b>11.9</b> |
| September | .9 | 0  | .5  | .9  | 1.4 | 0           | <b>96.4</b> |

**South Minch.**

|            | I    | II  | III  | VI   | V    | VII | VII         |
|------------|------|-----|------|------|------|-----|-------------|
| February.. | 2.9  | 6.6 | 0.8  | 0.4  | 0    | 0   | <b>89.3</b> |
| March....  | 2.5  | 4.5 | 0.41 | 1.6  | 0.4  | 0   | <b>90.6</b> |
| April....  | 22.5 | 0.8 | 0    | 0    | 0    | 0.4 | <b>76.4</b> |
| October..  | 0.5  | 0.9 | 6.3  | 4.5  | 0.9  | 0.9 | <b>86.0</b> |
| November   | 4.5  | 1.8 | 3.7  | 9.6  | 10.4 | 1.4 | <b>68.2</b> |
| December   | —    | 4.6 | 4.1  | 17.0 | 16.8 | 0.3 | <b>57.3</b> |

**Mean Vert. S.**

**North Minch.**

|          | I    | II | III  | IV   | V    | VI    | VII   | All maturities |
|----------|------|----|------|------|------|-------|-------|----------------|
| March..  | —    | —  | 56.5 | 56.9 | 56.9 | 56.9  | 56.9  | 56.9           |
|          |      |    | (6)  | (36) | (43) | (331) | (57)  |                |
| Sept.... | 57.0 | —  | 56.0 | 56.5 | 55.5 | —     | 56.2  | 56.2           |
|          | (1)  |    | (1)  | (2)  | (2)  |       | (201) |                |

**South Minch.**

|          | I    | II   | III  | IV   | V    | VI   | VII   | All maturities |
|----------|------|------|------|------|------|------|-------|----------------|
| Febr.... | 56.1 | 56.3 | 57.0 | 57.0 | —    | —    | 56.4  | 56.4           |
|          | (8)  | (16) | (2)  | (1)  |      |      | (214) |                |
| March..  | 56.3 | 56.6 | 57.0 | 56.8 | 57.0 | —    | 56.6  | 56.6           |
|          | (6)  | (11) | (1)  | (1)  | (1)  |      | (214) |                |
| April..  | 56.8 | 57.0 | —    | —    | —    | 57.0 | 56.4  | 56.5           |
|          | (55) | (2)  |      |      |      | (1)  | (197) |                |
| October  | 58.0 | 56.5 | 57.1 | 56.7 | 57.5 | 57.5 | 56.5  | 56.6           |
|          | (1)  | (2)  | (14) | (10) | (2)  | (2)  | (189) |                |
| Nov....  | 56.5 | 56.7 | 57.1 | 57.4 | 57.1 | 57.2 | 56.5  | 56.7           |
|          | (28) | (11) | (23) | (60) | (65) | (9)  | (420) |                |
| Dec....  | —    | 56.2 | 56.8 | 57.0 | 57.1 | 55.0 | 56.5  | 56.7           |
|          |      | (17) | (15) | (67) | (65) | (1)  | (220) |                |

(No. of fish in brackets)

Length frequencies, age composition and racial data for each month in which samples were obtained are summarised in Figure 8 and Table 12. The North Minch samples were obtained from catches by drift-net, and the South Minch samples from ring-net catches.

In March the samples from the two areas differed markedly in racial character. In the North Minch the fish were almost entirely spring spawners while in the South at the same time the stock appeared to be composed mainly of autumn spawners. During the months of October, November and December the composition of the fish stocks on the grounds was a mixture of autumn and spring spawners. The proportion of spring spawners increased from month to month but judging from the maturity data, was never greater than 40%.

Clyde.

Samples of herring were also obtained at intervals during the Clyde fishery. These however have not as yet been worked up.

**Tagging Experiments.**

Three types of tags were used: (1) LEA's Hydrostatic; (2) Plastic Strip (original Danish type), and (3) the Scottish Toggle Tag.

The following summaries apply only to herring tagged from drift-net catches, the great majority on commercial drifters.

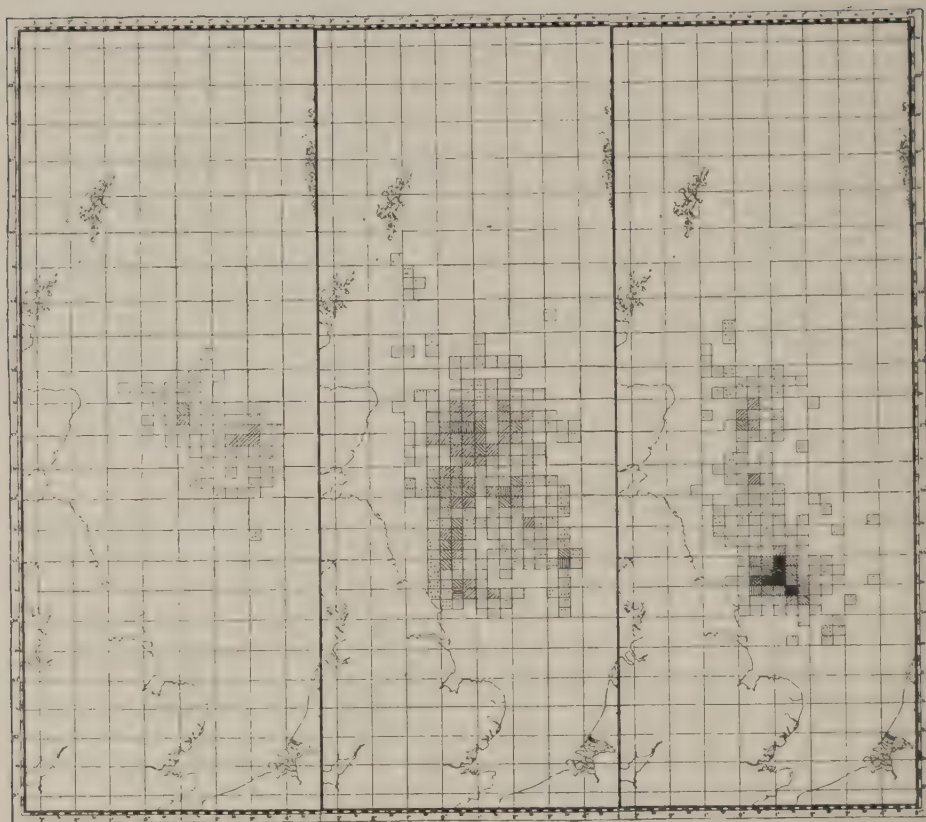
| Tag                                        | Date of Tagging   | Fish Tagged | Tags Recovered |
|--------------------------------------------|-------------------|-------------|----------------|
| LEA's Hydrostatic with modified bridle.... | May.....          | 94          | 0              |
| with Toggle attachment                     | May.....          | 1392        | 50             |
| Plastic Strip.....                         | 2.—9. June...     | 410         | 10             |
| Scottish Toggle.....                       | 12. June—5. Sept. | 5774        | 57             |
|                                            | Total.....        | 7670        | 117            |

A summary of tagging grounds and of areas where tagged herring were recaptured is given on the next page.

A point of considerable interest is that of the 16 recoveries from N.E. England, Dogger, East Anglia, Ostend and Skagerak, 13 had been tagged in May and 3 in June.

No recoveries have so far been obtained from the tagging in August of 122 herring caught in "Explorer's" trawl on the Fladen Ground. The results of tagging trawl-caught herring have so far been discouraging. The recoveries recorded in 1950 were all made within a few days after tagging and contributed nothing to our migration study.

Number of Shots.



Charts 1—3.

May

June

July

Tagging Experiments.

| Fish tagged | Date              | Shetland Recaptures                 | Days free |
|-------------|-------------------|-------------------------------------|-----------|
| 1867        | 15. June-13. July | 1 — Shetland.....                   | 21        |
|             |                   | 11 — Fladen.....                    | 13—128    |
|             |                   | 1 — Off Fraserburgh .               | 43        |
|             |                   | 1 — N. W. Dogger...                 | 108       |
|             |                   | East of Orkney                      |           |
| 100         | 21. July          | 2 — E. of Orkney....                | 1—11      |
|             |                   | off Fraserburgh and Peterhead       |           |
| 5703        | 15. May-4. Sept.  | 23 — off F'burgh and Peterhead..... | 1—59      |
|             |                   | 46 — Fladen.....                    | 10—123    |
|             |                   | 7 — Gut.....                        | 18—100    |
|             |                   | 4 — off N.E. England.               | 83—131    |
|             |                   | 9 — N.W. Dogger....                 | 74—142    |
|             |                   | 1 — off East Anglia...              | 178       |
|             |                   | 1 — off Ostend.....                 | 237       |
|             |                   | 1 — Skagerak.....                   | 263       |

Tagging on a small scale was inaugurated on

the west coast of Scotland during 1951, the following results were obtained to date:

| Fish tagged | Date of Tagging    | Recaptures    | Days free      |
|-------------|--------------------|---------------|----------------|
| 499         | 27. June—5. July   | 2             | 1—53           |
| 436         | 13. Sept.—19. Dec. | 2             | 48—55          |
|             |                    | H. WOOD.      | B. B. PARRISH. |
|             |                    | I. G. BAXTER. | G. MCPHERSON.  |

References.

- DE VEEN, J. (1950) *Ann. Biol.*, Vol. VII, p. 131.  
 WOOD, H. (1950) *ibid.* pp. 128—131.

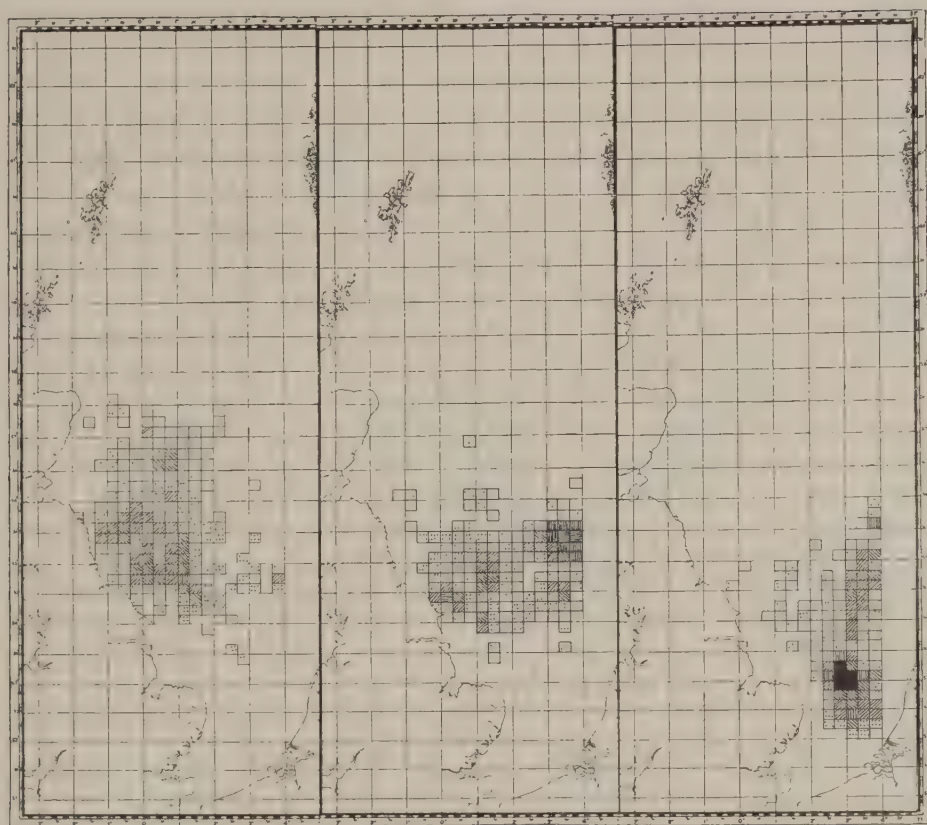
The Dutch Herring Fisheries in 1951.

Drift-Net Fisheries.

The data of the Dutch herring drift-net fisheries in 1951 cover about 70% of the fishing activity of the whole lugger fleet. The fishery started about the middle of May, in the first



Number of Shots.



Charts 4—6.

August

September

October

Number of Shots.

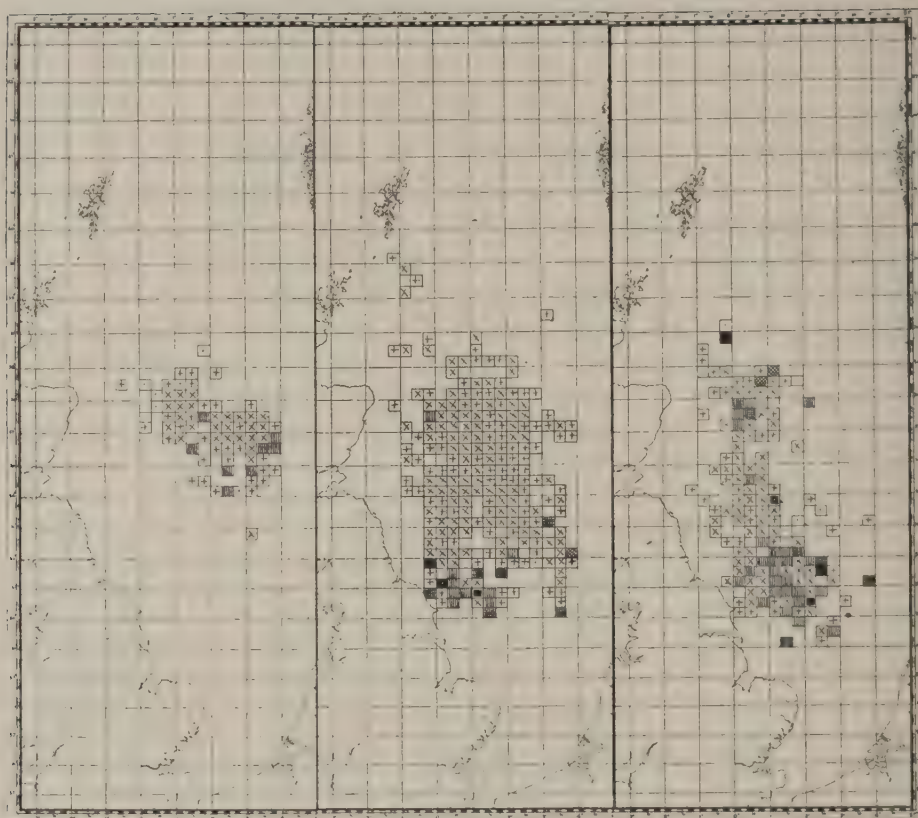


Charts 7—8.

November

December

Mean Catch per Shot (in kantjes).



Charts 9-11.

May

June

July

weeks with 60 nets, later mostly with 100 nets, which were set either for surface or for deeper water fishing.

The Charts 1-24 give the results.

The distribution of the fleet was nearly the same as in 1950, except in June and July, when the luggers were fishing more southerly than in 1950.

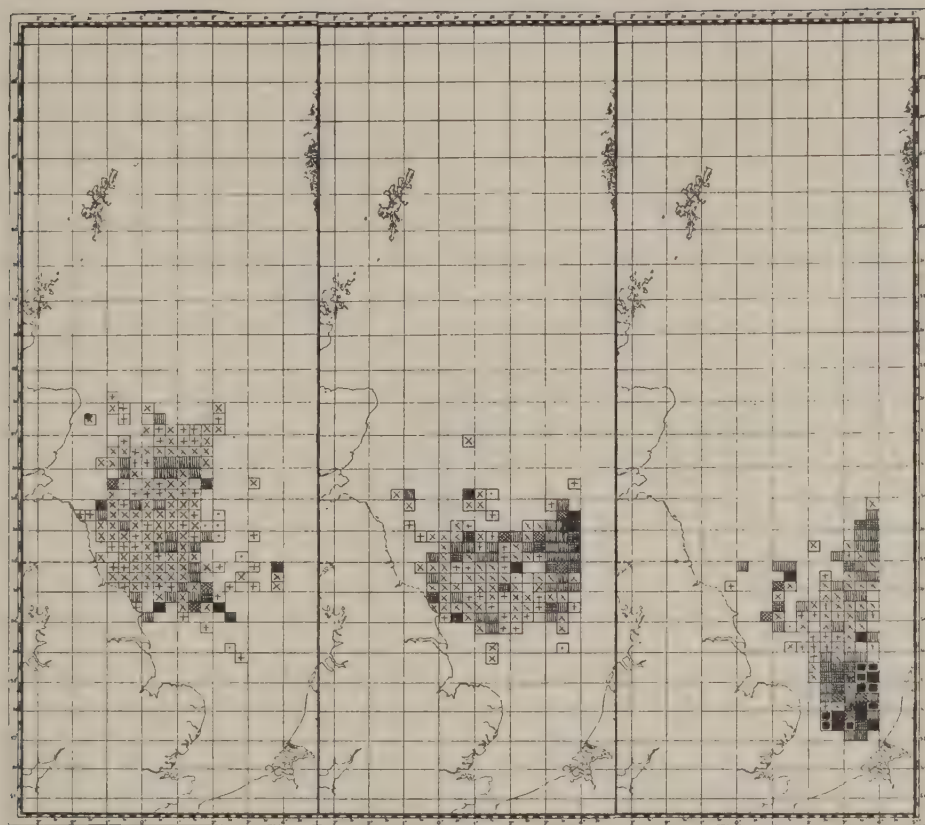
In June, July and August the best catches have been made between  $54^{\circ}$  and  $55^{\circ}$  N., more southerly than in 1950.

The catches of East Anglian herring were below 1950 in October, but somewhat higher than in 1950 in November and December.

Table 13A gives the total quantity of drift-net herring landed. The high landings in spring are caught near the Norwegian coast. These data have not been included in the charts. The total quantity landed is nearly the same as in 1950.

J. DE VEEN.

Mean Catch per Shot (in kantjes).

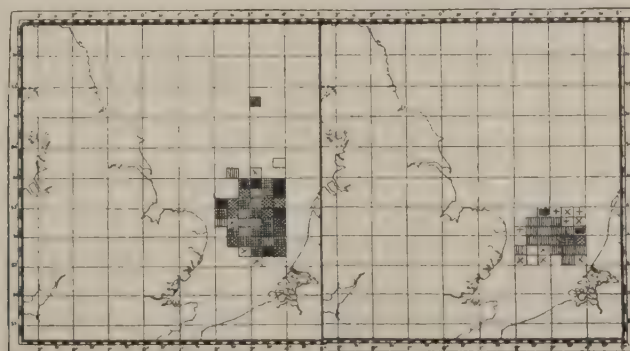


Charts 12—14.

August

September

October

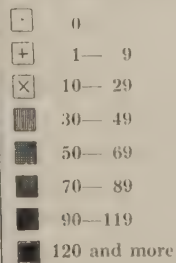


Charts 15—16.

November

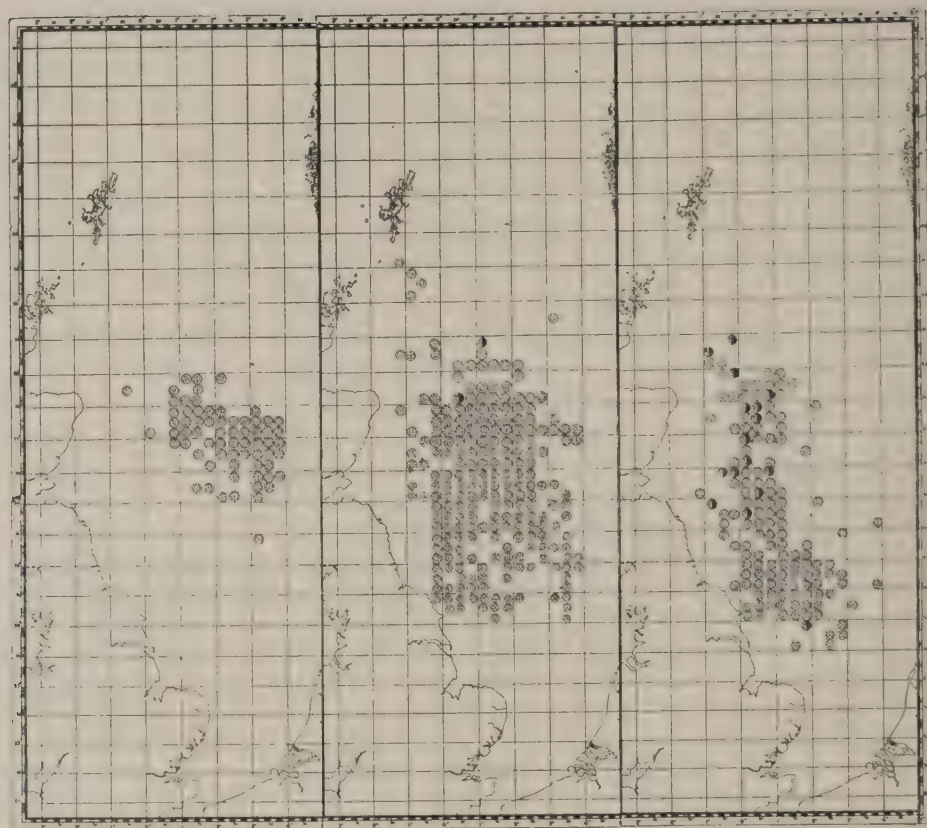
December

Mean Number of  
Kantjes per Shot





## Sorting.



Charts 17-19.

May

June

July

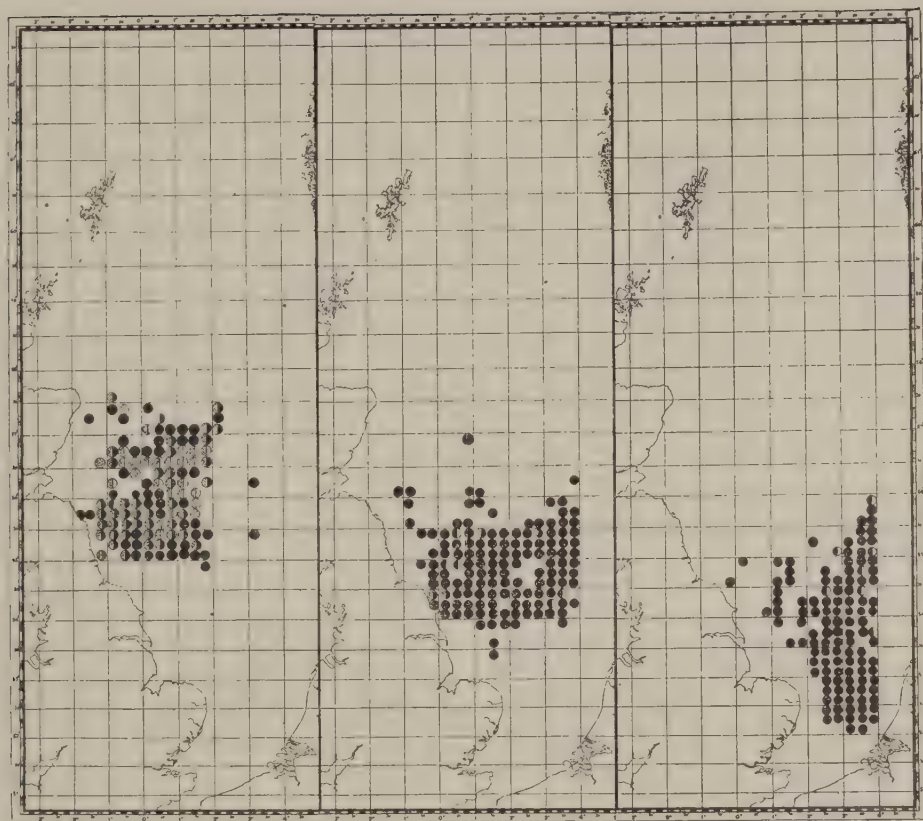
Table 13. Quantities of Herring landed in Dutch Ports.

## A. Landed in 1951 by the Luggers fishing with Drift-Nets.

## B. Trawled Herring (in tons) landed in 1951.

| Month           | Salted herring (in kantjes of 94 kg.) |             |       |          | Fresh herring | Trawlers | All kinds of vessels |
|-----------------|---------------------------------------|-------------|-------|----------|---------------|----------|----------------------|
|                 | Matjes                                | Gutted Full | Spent | Ungutted |               |          |                      |
| January.....    | —                                     | —           | —     | —        | 5,500         | 12       | 60                   |
| February.....   | —                                     | —           | —     | —        | —             | 390      | 395                  |
| March.....      | —                                     | —           | —     | —        | —             | 669      | 816                  |
| April.....      | —                                     | —           | —     | —        | 187,298       | 374      | 396                  |
| May.....        | 6,904                                 | —           | —     | 116      | 77,111        | 250      | 280                  |
| June.....       | 39,498                                | —           | —     | 1,167    | 240           | 253      | 269                  |
| July.....       | 92,779                                | 510         | —     | 4,563    | 160,295       | 822      | 1,259                |
| August.....     | 21,776                                | 5,373       | 14    | 2,844    | —             | 3,994    | 11,898               |
| September.....  | 5,434                                 | 43,738      | 1,147 | 16,998   | 113,575       | 6,219    | 15,800               |
| October.....    | 155                                   | 52,943      | 5,490 | 157,563  | 2,919,557     | 6,764    | 9,443                |
| November.....   | —                                     | 2,162       | 114   | 197,229  | 5,440,681     | 374      | 409                  |
| December.....   | —                                     | 476         | 921   | 94,540   | 2,308,584     | 882      | 1,101                |
| Total 1951..... | 166,546                               | 105,202     | 7,686 | 475,020  | 11,212,841    | 21,004   | 42,126               |

Sorting.



Charts 20—22.

August

September

October



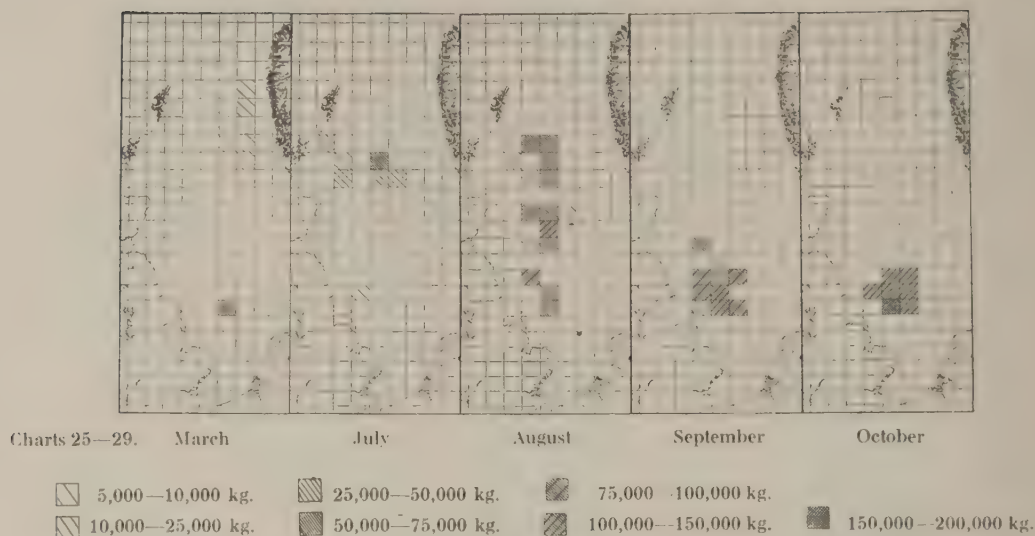
Charts 23—24.

November

December

- Matjes.
- Full.
- Matjes and Full.
- Full and Spent.
- Matjes, Full and Spent.

# Dutch Catches of Trawled Herring.



## Trawl Fisheries.

The catch of herring per 100 hours fishing of the Dutch steam trawlers fishing with the herring trawl is shown in the Charts 25-29.

The distribution of the fleet shows some differences with 1950. In March rather large catches (of spent herring) have been made in the area near Silver Pit.

The mean catches in the months July, August and September have been about the same as in 1950. The mean catches in October were considerably higher than the year before. This depends partly on the differences in the areas where the fleet has been fishing.

The Table 13 B gives the quantity of herring landed by the trawlers and by the whole fleet fishing with trawl-nets. The total quantity landed was much higher in 1951 than in 1950.

L. K. BOEREMA.

## Full-Herring Concentrations exploited by the Belgian Herring Trawlers in 1951.

### I. Activity—Landings—Value.

The first full-herring catch was landed on the 23. July 1951, it came from the Fladen Ground. The herring fishery went on there until September, but from mid-September most trawlers were already active in the central area, viz., the Gut and west of this fishing

ground. From October until the beginning of November, the fishery took place still more southerly, especially in the Bruceys Garden and on the western and south-western part of the Dogger Bank. From mid-November until 12. December, the fishery was carried out in the southernmost area of the North Sea, particularly around the lightships "Ruytingen", "Sandettié" and "Dyck".

The numbers of trawlers, voyages etc., catch and value for the years 1946-50 have been summarized in Ann. Biol., Vol. VII, Table 12, p. 139.

Comparing the activity of the herring trawlers with the season 1950, we must admit a slight decrease in 1951. The number of trawlers which have taken part in the campaign fell from 40 to 38; the number of voyages however increased from 213 to 215, whereas the number of H.P. developed-fishing hour decreased from 6,493,488 to 6,277,371, being a decrease of 216,117 H.P. developed-fishing hour, or 3.3%.

The total landings were 5,794 tons against 7,555 in 1950, this means a decrease of 23%.

The average catch per voyage also shows a marked diminution from 35 tons to 27 tons, or 24%.

The average catch per hour's fishing for 100 H.P. developed is also lower, 92 Kg. against 116 Kg. in 1950, being 21% less. This decrease



**Table 14. Number of Belgian Herring Trawlers (T), of Voyages (V), of Sea-Days (S.D.) and of Effective Fishing Hours (F.H.)**

**according to Classes of Vessels and Fishing Grounds.**

| Fishing<br>Grounds<br>and Months | Class III |    | Class IV |    | Class V |    | Class VI |    | Total |     | Class III |       | Class IV |       | Class V |       | Class VI |       | Total |        |
|----------------------------------|-----------|----|----------|----|---------|----|----------|----|-------|-----|-----------|-------|----------|-------|---------|-------|----------|-------|-------|--------|
|                                  | T         | V  | T        | V  | T       | V  | T        | V  | T     | V   | S.D.      | F.H.  | S.D.     | F.H.  | S.D.    | F.H.  | S.D.     | F.H.  | S.D.  | F.H.   |
| <b>North Sea, North</b>          |           |    |          |    |         |    |          |    |       |     |           |       |          |       |         |       |          |       |       |        |
| July.....                        | —         | —  | 3        | 3  | 3       | 3  | 2        | 2  | 8     | 8   | —         | —     | 36       | 553   | 27      | 329   | 21       | 242   | 84    | 1,124  |
| August.....                      | —         | —  | 6        | 7  | 4       | 5  | 4        | 8  | 14    | 20  | —         | —     | 77       | 890   | 56      | 621   | 81       | 970   | 214   | 2,481  |
| September.....                   | —         | —  | 1        | 1  | 2       | 2  | 3        | 3  | 6     | 6   | —         | —     | 12       | 135   | 21      | 316   | 28       | 313   | 61    | 764    |
| Total.....                       | —         | —  | 6        | 11 | 7       | 10 | 4        | 13 | 17    | 34  | —         | —     | 125      | 1,578 | 104     | 1,266 | 130      | 1,525 | 359   | 4,369  |
| <b>North Sea, Central</b>        |           |    |          |    |         |    |          |    |       |     |           |       |          |       |         |       |          |       |       |        |
| August.....                      | —         | —  | 7        | 9  | 4       | 5  | 1        | 1  | 12    | 15  | —         | —     | 105      | 1,105 | 52      | 569   | 11       | 112   | 168   | 1,786  |
| September.....                   | —         | —  | 7        | 13 | 6       | 14 | 4        | 5  | 17    | 32  | —         | —     | 114      | 1,107 | 131     | 1,257 | 49       | 474   | 294   | 2,838  |
| October.....                     | —         | —  | 4        | 12 | 8       | 16 | 2        | 4  | 14    | 32  | —         | —     | 99       | 990   | 128     | 1,259 | 31       | 296   | 258   | 2,545  |
| November.....                    | —         | —  | 3        | 3  | 6       | 6  | 1        | 1  | 10    | 10  | —         | —     | 31       | 297   | 61      | 677   | 10       | 80    | 102   | 1,054  |
| Total.....                       | —         | —  | 9        | 37 | 8       | 41 | 6        | 11 | 23    | 89  | —         | —     | 349      | 3,499 | 372     | 3,762 | 101      | 962   | 822   | 8,223  |
| <b>North Sea, South</b>          |           |    |          |    |         |    |          |    |       |     |           |       |          |       |         |       |          |       |       |        |
| November..                       | 11        | 42 | 4        | 14 | 2       | 4  | 1        | 2  | 18    | 62  | 207       | 1,560 | 49       | 366   | 25      | 229   | 11       | 108   | 292   | 2,263  |
| December..                       | 9         | 25 | 2        | 5  | —       | —  | —        | —  | 11    | 30  | 95        | 778   | 21       | 94    | —       | —     | —        | —     | 116   | 872    |
| Total.....                       | 11        | 67 | 4        | 19 | 2       | 4  | 1        | 2  | 18    | 92  | 302       | 2,338 | 70       | 460   | 25      | 229   | 11       | 108   | 408   | 3,135  |
| Seasonal Total                   | 11        | 67 | 12       | 67 | 8       | 55 | 6        | 26 | 37    | 215 | 302       | 2,338 | 544      | 5,537 | 501     | 5,257 | 242      | 2,595 | 1,589 | 15,727 |

The average duration of a voyage was 7.38 sea-days or 73.15 fishing hours.

denotes that an equal effort produced by the trawlers gave a smaller catch than in 1950. From this we may infer that the herring concentrations exploited by the Belgian fishermen during 1951 were not so dense as during the previous year. However, this conclusion does

not apply to the northern area, since the average catch for one hour's fishing for 100 H.P. developed reached a much higher level, 73 Kg. against 64 Kg. in 1950.

The value of the herring catch reached 21.6 mill. fr. being 12% less than in 1950.

**Table 15. Total Weight landed (in 1000 Kg.) and the Average Catch per Voyage (C V) in 1000 Kg. and per Hour per 100 H.P. (C/H) (in Kg.).**

|                         | Class III | Class IV | Class V | Class VI | Total | Class III | Class IV | Class V | Class VI | Total |
|-------------------------|-----------|----------|---------|----------|-------|-----------|----------|---------|----------|-------|
|                         | C/V       | C/H      | C/V     | C/H      | C/V   | C/V       | C/H      | C/V     | C/H      | C/V   |
| <b>Northern section</b> |           |          |         |          |       |           |          |         |          |       |
| July.....               | —         | —        | 35      | 70       | 121   | 226       | —        | —       | 12       | 22    |
| August.....             | —         | —        | 180     | 241      | 669   | 1090      | —        | —       | 26       | 70    |
| September.....          | —         | —        | 19      | 55       | 271   | 345       | —        | —       | 19       | 47    |
| Total.....              | —         | —        | 234     | 366      | 1061  | 1661      | —        | —       | 21       | 51    |
| <b>Central section</b>  |           |          |         |          |       |           |          |         |          |       |
| August.....             | —         | —        | 222     | 212      | 99    | 533       | —        | —       | 25       | 67    |
| September.....          | —         | —        | 420     | 604      | 420   | 1443      | —        | —       | 32       | 131   |
| October.....            | —         | —        | 481     | 699      | 323   | 1502      | —        | —       | 40       | 181   |
| November.....           | —         | —        | 64      | 114      | 50    | 228       | —        | —       | 21       | 72    |
| Total.....              | —         | —        | 1187    | 1629     | 891   | 3707      | —        | —       | 32       | 118   |
| <b>Southern section</b> |           |          |         |          |       |           |          |         |          |       |
| November.....           | 175       | 63       | 57      | 45       | 340   | 4.2       | 51       | 4.5     | 66       | 14    |
| December.....           | 69        | 17       | —       | —        | 86    | 3.8       | 49       | 3.3     | 72       | —     |
| Total.....              | 244       | 80       | 57      | 45       | 426   | 4.6       | 50       | 4.2     | 67       | 14    |
| Seasonal Total.         | 244       | 1501     | 2052    | 1997     | 5794  | 3.6       | 50       | 22      | 95       | 37    |
| Percentage ....         | 4.2       | 25.9     | 35.4    | 34.5     | 100   | —         | —        | —       | —        | —     |

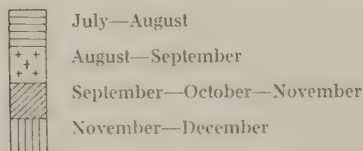
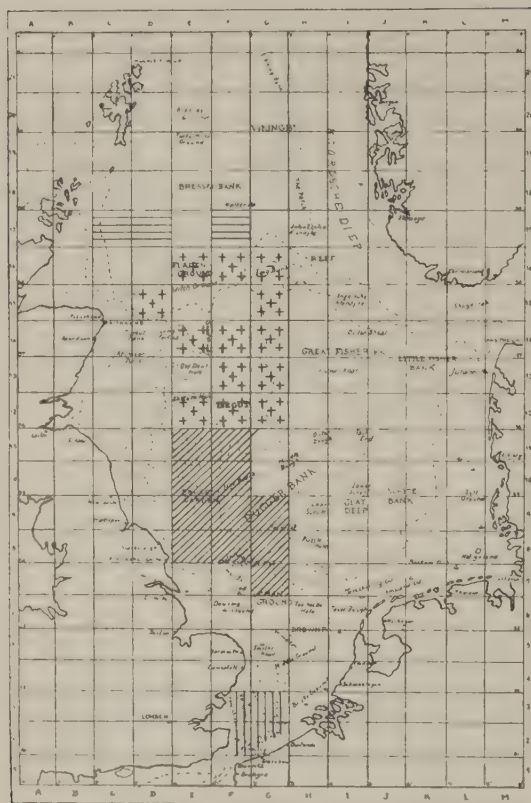


Figure 9. Fishing grounds exploited by Belgian herring trawlers in 1951.

## II. Biology.

The material comprises 15 samples of which 7 were from the northern area, mainly the Fladen Ground and Long Forties, and 8 from the central area, Bruceys Garden as well as west and south-west of the Dogger Bank. The former area was fished mostly during August and the latter during September and October.

The average length of the herring was:—

|              | Northern area | Central area | Both areas |
|--------------|---------------|--------------|------------|
| in 1951..... | 276 mm.       | 261 mm.      | 267 mm.    |
| in 1950..... | 263 —         | 257 —        | 261 —      |

Table 16. Catch of Full Herring in the Season.

|               | Total<br>1000 Kg. | %    | Per voyage<br>in 1000 Kg. | Per eff. hour<br>per 100 H. P.<br>in Kg. |
|---------------|-------------------|------|---------------------------|------------------------------------------|
| July.....     | 226               | 3.9  | 28                        | 45                                       |
| August.....   | 1623              | 28.0 | 46                        | 81                                       |
| September.... | 1788              | 30.9 | 47                        | 111                                      |
| October.....  | 1502              | 25.9 | 47                        | 155                                      |
| November..... | 569               | 9.8  | 8                         | 55                                       |
| December..... | 86                | 1.5  | 3                         | 52                                       |
| Total.....    | 5794              | 100  | 27                        | 92                                       |

The average length increased slightly in the two areas. The average weight is also somewhat higher, 162 gr. against 155 gr.

Comparing the numerical strength of the year-classes observed, we ascertained that the youngest generations (three to six-year-old herrings) although they were already very well represented in the 1950 concentrations were still better represented this year: 68.2% against 61.3%.

The average number of vertebrae for the northern area was 56.62 that for the central area 56.51 and for the two areas 56.55.

Table 17. Average Numbers of Sea-Days and of Effective Fishing Hours per Voyage.

|              | Sea-days | Fishing hours |
|--------------|----------|---------------|
| Northern.... | 10.6     | 128.5         |
| Central..... | 9.2      | 92.4          |
| Southern.... | 4.4      | 34.1          |

The average number of vertebrae of the herrings, which during August belonged to the maturity stages I to III, and which we consider to be spring spawners, was 56.81 and for those with maturity stages IV to VIII—II + stages I to III from September, considered to be autumn spawners, 56.51.

The spring spawners represented 34.5% of the catch in the northern area; they are totally missing in the catches from the central area. This result corroborates once more the fact

Table 18. Total Seasonal Weight in 1951.

|                 | Weight<br>(1000 Kg.) | Percentage |
|-----------------|----------------------|------------|
| Herring.....    | 5794                 | 89.5       |
| Mackerel.....   | 334                  | 5.2        |
| Demersal fish.. | 344                  | 5.3        |
| Shellfish.....  | 2                    | 0.04       |
| Total.....      | 6474                 | 100        |

**Table 19. Full Herring. Length, Weight, Sex, Maturity, Fat Content, and Age (Percentages).****A. Centimetre Class, Mean Length (cm.), Average Weight (gr.), and Sex (Percentages).**

|             | Centimetre Classes |     |     |     |     |      |      |      |      |      |      |     | Aver. Weight | Males % |
|-------------|--------------------|-----|-----|-----|-----|------|------|------|------|------|------|-----|--------------|---------|
|             | 19                 | 20  | 21  | 22  | 23  | 24   | 25   | 26   | 27   | 28   | 29   | 30  | 31           |         |
| Northern... | —                  | —   | —   | —   | 0.3 | 1.8  | 11.2 | 19.2 | 22.0 | 29.7 | 11.5 | 4.0 | 0.3          | 27.6    |
| Central...  | 0.2                | 0.3 | 0.3 | 0.9 | 6.4 | 11.0 | 24.8 | 26.7 | 18.2 | 7.0  | 3.7  | 0.3 | 0.2          | 26.1    |
| Total....   | 0.1                | 0.2 | 0.2 | 0.6 | 4.0 | 7.5  | 19.6 | 23.9 | 19.6 | 15.7 | 6.7  | 1.7 | 0.2          | 26.7    |

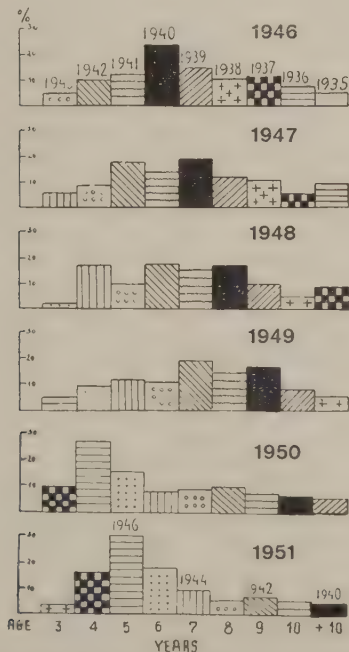
**B. Stages of Maturity and Quantity of Mesenteric Fat.**

|               | Stages of Maturity |     |      |      |      |      |         | Quantity of Fat |      |      |      |
|---------------|--------------------|-----|------|------|------|------|---------|-----------------|------|------|------|
|               | I                  | II  | III  | IV   | V    | VI   | VIII-II | 0               | I    | +    | M    |
| Northern..... | 4.0                | 2.8 | 27.7 | 38.7 | 26.8 | —    | —       | 3.5             | 24.5 | 38.5 | 33.5 |
| Central.....  | 2.2                | 3.4 | 5.9  | 23.1 | 36.8 | 16.8 | 11.8    | 23.8            | 39.4 | 25.9 | 10.9 |
| Total.....    | 2.9                | 3.2 | 14.2 | 29.1 | 33.0 | 10.3 | 7.3     | 16.0            | 33.7 | 30.8 | 19.5 |
| 1. group..... | 11.6               | 8.0 | 80.4 | —    | —    | —    | —       | 0.7             | 0.7  | 17.4 | 81.2 |
| 2. group..... | 1.6                | 2.4 | 4.2  | 33.5 | 38.0 | 11.9 | 8.4     | 18.3            | 38.7 | 32.8 | 10.2 |

**C. Distribution of Year-Classes and Age-Groups.**

Number of Herrings with readable scales: 233.

|                   | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10          | +            | Number of |
|-------------------|------|------|------|------|------|------|------|------|-------------|--------------|-----------|
| Winter-Rings..... | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10          | +            | Fish      |
| Age (Years).....  | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | +           | +            |           |
| Year-Classes..... | 1948 | 1947 | 1946 | 1945 | 1944 | 1943 | 1942 | 1941 | Before 1941 | 1941 Samples | Fish      |
| Northern.....     | 2.4  | 10.6 | 20.0 | 20.0 | 15.3 | 9.4  | 7.0  | 8.2  | 7.1         | 7            | 400       |
| Central.....      | 4.0  | 19.6 | 36.5 | 16.9 | 5.4  | 3.4  | 6.8  | 4.0  | 3.4         | 8            | 644       |
| Total.....        | 3.4  | 16.3 | 30.5 | 18.0 | 9.0  | 5.6  | 6.9  | 5.6  | 4.7         | 15           | 1044      |

**Figure 10. Biological Scale of the Full-Herring Concentrations exploited by the Belgian Herring Trawlers during the years 1946—1951.**

that the spring spawners penetrate the central area of the North Sea only in small numbers.

In 1950, the spring spawners represented 41.4% of the catch from the northern area.

As is normal, the average number of keeled scales was somewhat higher for the autumn spawners than for the spring spawners, or respectively 14.70 and 14.67.

#### **Stomach Contents.**

Among the 1,044 stomachs examined only 81, or 7.8%, were found to have some contents: 17, or 1.6%, full; 32, or 3.1%, half-full and 32, or 3.1%, a quarter full.

The contents observed consisted for the greater part of copepods and smaller quantities of schizopods.

#### **III. Forecasts for the Full-Herring Campaign 1952.**

If we analyse the composition of the last fished full-herring concentrations (1951), we ascertain that the three-year-old herrings (year-class 1948), which joined the full-herring concentrations for the first time, were only very poorly represented (3.4%). On the other hand, the five-year-old herrings (year-class 1946) were exceptionally well represented (30.5%). The four-year-olds (year-class 1947) and the



**Table 20. Full Herring. Average Length and Average Value of  $L_1$  of each Year-Class.**

|               | Length of Year-Classes, cm. |      |      |      |      |      |      |      | $L_1$ of Year-Classes, in mm. |      |      |      |      |      |      |      | Mean |
|---------------|-----------------------------|------|------|------|------|------|------|------|-------------------------------|------|------|------|------|------|------|------|------|
|               | 1948                        | 1947 | 1946 | 1945 | 1944 | 1943 | 1942 | 1941 | 1948                          | 1947 | 1946 | 1945 | 1944 | 1943 | 1942 | 1941 |      |
| Born in:..... | 3                           | 4    | 5    | 6    | 7    | 8    | 9    | 10   |                               |      |      |      |      |      |      |      |      |
| Age:.....     | 23.9                        | 26.3 | 26.8 | 27.2 | 28.0 | 28.6 | 28.1 | 28.5 | 100                           | 110  | 114  | 108  | 114  | 133  | 112  | 115  | 114  |
| Northern..... | 24.3                        | 25.8 | 26.5 | 27.2 | 27.6 | 27.6 | 27.6 | 28.5 | 119                           | 116  | 108  | 112  | 101  | 108  | 107  | 110  | 111  |
| Central.....  | 24.2                        | 25.9 | 26.6 | 27.2 | 27.9 | 28.2 | 27.8 | 28.5 | 114                           | 115  | 109  | 110  | 109  | 123  | 109  | 113  | 112  |
| Total.....    |                             |      |      |      |      |      |      |      |                               |      |      |      |      |      |      |      |      |

six-year-olds (year-class 1945) were well represented (16.3% and 18.0% respectively).

Relying upon the above-mentioned percentages, we may expect that the 1948 year-class will not be well represented in the next nor in the later concentrations, whereas the 1947, 1946 and 1945 year-classes will always assure a large share until they reach an old age.

However, to infer from this that the coming season will yield large catches, would be to judge prematurely.

As is being constantly pointed out, good catches do not depend solely on the density of the concentrations, but rather upon the weather and hydrological conditions, which occur during the campaign. Also, it would not be the first time that the exploitation of the concentrations was adversely affected by them and in this way belie the favourable forecasts of a campaign.

In consequence, it is only if the weather and the hydrological conditions affect the exploitation favourably that we may expect, in 1952, a satisfactory full-herring season.

CH. GILIS.

### Spent-Herring Concentrations on the Belgian and French Coasts. 1951—52.

#### A. Fishery.

##### I. Period, Fishing Grounds and Methods.

The spent-herring season 1951—52 was of longer duration than the previous one. The

first catches were landed on 12. December 1951 and the last on 29. February 1952. During this period there were 61 days of sale, viz., 18 in December, 21 in January and 22 in February. The previous campaign started 6 days earlier, but finished also a month sooner (from 6. Dec. till 27. Jan.) and counted only 42 days of sale.

As in 1950—51, it was only at the beginning of the season that dense spent-herring concentrations were to be found in the Belgian territorial waters. As from January, the spent-herring left once and for all the Belgian waters and from then onwards the Belgian trawlers were active in the areas between the light-vessels "Ruytingen" and "Dyck" as well as in areas further north.

Concerning the fishing methods, it must be mentioned, that in contrast with the previous season, the fishery with the "bull-net" again met with great success and this time both among the largest and the smallest trawlers.

#### II. Activity of the Herring Fleet and Catch.

A total of 52 trawlers took part in the spent-herring campaign 1951—52, or 15 less than during the previous season:

| Class | Number  |         | Type                    | H.P.    |
|-------|---------|---------|-------------------------|---------|
|       | 1950-51 | 1951-52 |                         |         |
| I     | 13      | 6       | shrimp boats.....       | — 79    |
| II    | 21      | 8       | coastal trawlers.....   | 80—119  |
| III   | 27      | 29      | medium-sized trawlers . | 120—239 |
| IV    | 6       | 9       | small deep-sea trawlers | 240—300 |

**Table 21. Full Herring. Racial Characters. Percentage Distribution and Means.**

| Origin      | Number of Vertebrae <sup>1)</sup> |      |      |      |     | Number of $K_2$ |     |     |     |      |      |      |     |     |         | Average |
|-------------|-----------------------------------|------|------|------|-----|-----------------|-----|-----|-----|------|------|------|-----|-----|---------|---------|
|             | 55                                | 56   | 57   | 58   | 59  | Average         | 11  | 12  | 13  | 14   | 15   | 16   | 17  | 18  | Average |         |
| Northern... | 2.3                               | 41.9 | 47.7 | 7.9  | 0.2 | 56.62           | —   | 0.2 | 5.8 | 35.5 | 44.5 | 11.5 | 2.3 | 0.2 | 14.69   |         |
| Central...  | 5.8                               | 41.2 | 49.0 | 4.0  | —   | 56.51           | 0.2 | 0.2 | 6.3 | 34.1 | 44.1 | 13.5 | 1.1 | 0.5 | 14.69   |         |
| Total.....  | 4.4                               | 41.5 | 48.5 | 5.5  | 0.1 | 56.55           | 0.1 | 0.2 | 6.1 | 34.7 | 44.3 | 12.7 | 1.5 | 0.4 | 14.69   |         |
| 1. group... | 2.2                               | 30.2 | 52.9 | 14.0 | 0.7 | 56.81           | —   | 0.7 | 8.7 | 31.2 | 44.2 | 13.0 | 1.5 | 0.7 | 14.67   |         |
| 2. group... | 4.8                               | 43.2 | 47.8 | 4.2  | —   | 56.51           | 0.1 | 0.1 | 5.7 | 35.2 | 44.3 | 12.7 | 1.6 | 0.3 | 14.69   |         |

<sup>1)</sup> The census for the vertebrae covered 1,044 spines, of which there were 27, or 2.59%, with one or more fused vertebrae. These spines have been eliminated from our material.

**Table 22. Spent Herring. Number of Voyages and Catch in 1950—51 and 1951—52 of Trawlers fishing individually<sup>1)</sup>.**

| Number of Voyages |    |    |     |    |       | Total Weight landed in 1000 Kg. |     |      |     |       |     | Average Catch (Kg.) per fishing day/H.P. |      |      |      |       |
|-------------------|----|----|-----|----|-------|---------------------------------|-----|------|-----|-------|-----|------------------------------------------|------|------|------|-------|
| Class . . . .     | I  | II | III | IV | Total | I                               | II  | III  | IV  | Total | %   | I                                        | II   | III  | IV   | Total |
| 1950—51           |    |    |     |    |       |                                 |     |      |     |       |     |                                          |      |      |      |       |
| December.         | 22 | 34 | 53  | 5  | 114   | 43                              | 127 | 413  | 71  | 655   | 38  | 33.4                                     | 40.0 | 44.7 | 52.4 | 43.5  |
| January . .       | 8  | 42 | 139 | 38 | 227   | 22                              | 100 | 714  | 215 | 1052  | 62  | 41.0                                     | 24.7 | 30.2 | 21.8 | 27.6  |
| Total . . . .     | 30 | 76 | 192 | 43 | 341   | 66                              | 227 | 1127 | 286 | 1706  | 100 | 36.4                                     | 31.4 | 34.3 | 25.5 | 32.1  |
| 1951—52           |    |    |     |    |       |                                 |     |      |     |       |     |                                          |      |      |      |       |
| December.         | 9  | 19 | 59  | 13 | 100   | 26                              | 40  | 287  | 54  | 406   | 44  | 38.8                                     | 19.8 | 28.5 | 16.3 | 25.3  |
| January . .       | 8  | 21 | 50  | 19 | 98    | 31                              | 72  | 234  | 97  | 434   | 46  | 51.6                                     | 33.1 | 28.4 | 20.8 | 27.7  |
| February . .      | 4  | 12 | 5   | 6  | 27    | 24                              | 32  | 11   | 22  | 89    | 10  | 78.7                                     | 25.9 | 11.8 | 15.3 | 22.8  |
| Total . . . .     | 21 | 52 | 114 | 38 | 225   | 80                              | 144 | 532  | 173 | 930   | 100 | 51.6                                     | 26.5 | 27.6 | 18.4 | 26.1  |

<sup>1)</sup> Since some trawlers using the "bull-net" belonged to different classes of vessels, it is impossible to classify their catches according to class.

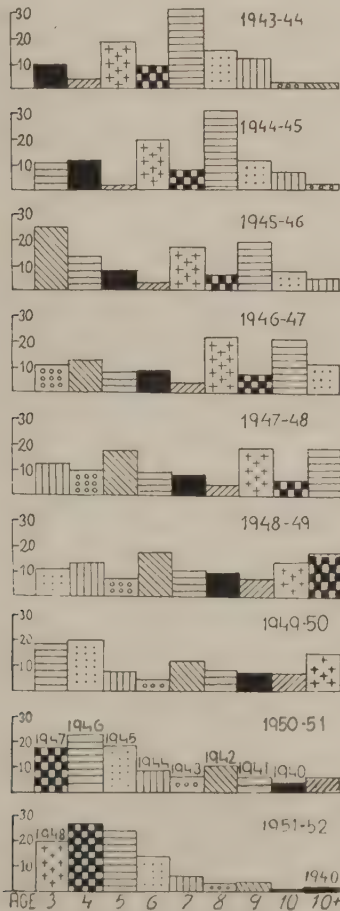


Figure 11. Biological Scale of the Spent-Herring Concentrations during the winters 1943/4 to 1951/2.

**Table 23. Number of Voyages and Catch in 1951—52 of Trawlers using the "Bull-Net"<sup>1)</sup> and total Catch of all Trawlers.**

|             | No. of voyages | Catch (1000 Kg.) in bull-net | Aver. Catch (Kg.) in all trawlers per fishing-day H.P. |
|-------------|----------------|------------------------------|--------------------------------------------------------|
| Dec. . . .  | 6              | 93                           | 449                                                    |
| Jan. . . .  | 38             | 577                          | 1011                                                   |
| Feb. . . .  | 133            | 1875                         | 1965                                                   |
| Total . . . | 177            | 2545                         | 3475                                                   |

<sup>1)</sup> See foot-note to Table 22.

During December there were 28 trawlers fishing individually and 6 fishing with the "bull-net"; during January 26 and 22 respectively and during February 11 and 33.

402 voyages or catches were made, of which 225, or 56% by trawlers fishing individually and 177, or 44% by trawlers using the "bull-net". During the season 1950—51, the catches with the "bull-net" were so rare that they were not taken into account, viz. 18, or 5.3% of the total.

**Table 24. The Catch in the Seasons 1941/42—1951/52.**

| Spent-Herring Season | Number of trawlers | Weight          |                                                |                   |                 |
|----------------------|--------------------|-----------------|------------------------------------------------|-------------------|-----------------|
|                      |                    | Total Mill. Kg. | Kg. per fishing day per 1 H.P. indiv. trawlers | bull-net trawlers | Value Mill. fr. |
| 1941—42              | 161                | 10.0            | 119                                            | —                 | 80.1            |
| 1942—43              | 290                | 51.9            | 164                                            | —                 | 352.5           |
| 1943—44              | 337                | 58.1            | 130                                            | —                 | 305.0           |
| 1944—45              | 280                | 31.4            | 160                                            | —                 | 167.0           |
| 1945—46              | 345                | 26.4            | 68                                             | —                 | 69.9            |
| 1946—47              | 346                | 22.1            | 50                                             | —                 | 40.8            |
| 1947—48              | 243                | 6.8             | 32                                             | —                 | 13.9            |
| 1948—49              | 258                | 9.5             | 26                                             | —                 | 17.2            |
| 1949—50              | 176                | 2.4             | 15                                             | 17                | 7.1             |
| 1950—51              | 67                 | 1.7             | 32                                             | 44                | 4.9             |
| 1951—52              | 52                 | 3.5             | 26                                             | 43                | 12.0            |

**Table 25. Percentage Distribution of Length, Maturity, Fat, Sex and Age.**

| A. Centimetre Classes, mean Length and mean Weight. |     |     |     |     |      |             |             |             |      |     |     |     |           |           |
|-----------------------------------------------------|-----|-----|-----|-----|------|-------------|-------------|-------------|------|-----|-----|-----|-----------|-----------|
| cm.                                                 | 19  | 20  | 21  | 22  | 23   | 24          | 25          | 26          | 27   | 28  | 29  | 30  | Mean, cm. | Mean, gr. |
| Dec.                                                | —   | —   | —   | 4.4 | 8.4  | 17.2        | 25.2        | <b>23.3</b> | 12.8 | 2.8 | 0.4 | —   | 25.6      | 114       |
| Jan.                                                | —   | —   | 0.5 | 4.8 | 15.5 | 17.2        | 22.5        | <b>23.0</b> | 12.8 | 3.2 | 0.5 | —   | 25.4      | 109       |
| Feb.                                                | —   | 0.3 | 0.3 | 4.3 | 15.0 | 18.7        | <b>24.7</b> | 22.3        | 12.3 | 1.6 | 0.3 | —   | 25.3      | 104       |
| Total 1951/52                                       | —   | 0.1 | 0.3 | 4.5 | 13.5 | 17.7        | 23.9        | <b>24.3</b> | 12.6 | 2.6 | 0.4 | —   | 25.4      | 109       |
| 1950/51                                             | 0.2 | 0.4 | 0.9 | 5.6 | 15.6 | <b>19.7</b> | 18.7        | 17.1        | 14.1 | 6.9 | 0.7 | 0.2 | 25.4      | 109       |

| B. Stages of Maturity, Mesenteric Fat and % of Males. |     |                 |    |     |     |     |             |             |             |             |                |     |       |   |
|-------------------------------------------------------|-----|-----------------|----|-----|-----|-----|-------------|-------------|-------------|-------------|----------------|-----|-------|---|
|                                                       |     | Maturity Stages |    |     |     |     |             |             |             | 0           | Mesenteric Fat |     | Males |   |
|                                                       |     | I               | II | III | IV  | V   | VI          | VII         | VIII-II     |             | 1              | +   | M     | % |
| Dec.                                                  | 0.4 | —               | —  | —   | —   | —   | 0.4         | 2.4         | <b>96.3</b> | 9.2         | <b>33.3</b>    | 2.0 | —     |   |
| Jan.                                                  | —   | 1.0             | —  | —   | 0.2 | 1.2 | 1.8         | <b>95.3</b> | 16.8        | <b>32.2</b> | 1.0            | —   |       |   |
| Feb.                                                  | —   | 1.7             | —  | —   | —   | —   | 1.0         | <b>97.3</b> | 15.7        | <b>32.3</b> | 1.7            | 0.3 |       |   |
| Total 1951/52                                         | 0.1 | 1.0             | —  | —   | 0.1 | 0.6 | 1.7         | <b>96.5</b> | 14.4        | <b>34.0</b> | 1.5            | 0.1 | 48    |   |
| 1950/51                                               | 0.9 | 1.5             | —  | —   | —   | 0.6 | <b>97.1</b> | —           | 18.7        | 72.2        | 7.1            | 2.1 | 49    |   |

| C. Year-Classes. (The number of herrings with readable scales: 493). |      |      |             |             |      |      |      |      |      |       |                            |
|----------------------------------------------------------------------|------|------|-------------|-------------|------|------|------|------|------|-------|----------------------------|
| Age (Years)                                                          | 2    | 3    | 4           | 5           | 6    | 7    | 8    | 9    | 10   | 10+   | Number of herrings invest. |
| Year-Class in Season 1951/52                                         | 1949 | 1948 | 1947        | 1946        | 1945 | 1944 | 1943 | 1942 | 1941 | 1941— |                            |
| Dec.                                                                 | —    | 10.4 | <b>23.1</b> | 19.8        | 20.8 | 10.4 | 5.2  | 3.1  | —    | 2.1   | 250                        |
| Jan.                                                                 | —    | 20.6 | 24.5        | <b>27.0</b> | 10.8 | 4.9  | 4.4  | 4.9  | 1.0  | 2.0   | 400                        |
| Feb.                                                                 | 1.0  | 23.3 | <b>23.0</b> | 22.3        | 14.0 | 6.2  | 1.0  | 3.1  | —    | 1.0   | 292                        |
| Total 1951/52                                                        | 0.4  | 19.7 | <b>26.6</b> | 23.7        | 14.0 | 6.5  | 3.2  | 3.8  | 0.4  | 1.6   | 942                        |
| — 1950/51                                                            | —    | 17.4 | <b>22.2</b> | 18.7        | 8.4  | 6.5  | 10.3 | 6.0  | 4.3  | 6.2   | 680                        |

Classified according to fishing methods the landings were as follows:—

Trawlers fishing individually: 930 t., or 27%.

Trawlers using the "bull-net": 2,545 t., or 73%.

If we compare the average catch per fish-day for 1 H.P. developed obtained by the trawlers fishing individually with that of the season 1950—51, we find that the average catch of last season dropped from 32 Kg. to 26 Kg. and that the average catch of the trawlers using the "bull-net" dropped from 43.9 Kg. to 43.3 Kg., or only 0.6 Kg.

The total seasonal value reached 12.0 mill. fr. or an average price of 3.47 fr. per Kg.

The value of the landings made by the individual trawlers reached 3.5 mill. fr., or

29% and that of the "bull-net" trawlers 8.6 mill. fr., or 71%. The value of last season was 146% higher than that of the 1950—51 season.

3.5 mill. Kg. spent herring were landed, an increase of 103.5% against the previous season.

The average catch per voyage was 4,131 Kg. for the trawlers fishing individually against 5,203 Kg. in 1950-51, or a decrease of 1,072 Kg.

This decline can on the one side be ascribed to the fact that, contrary to the previous season, the smallest units formed the majority of the trawlers fishing individually and on the other side that the average catch for 1 H.P. developed per fish day also decreased.

The average catch for the trawlers fishing with the "bull-net" was 14,380 Kg. against 6,631 Kg., or an increase of 7,749 Kg.

**Table 26. Average Length and average Value of  $L_1$  of each Year-Class.**

[illegible]



Table 27. Racial Characters. Percentage Distribution and Mean.

| Month      | 54   | Number of Vertebrae <sup>1)</sup> |      |      |     |     | Average | Number of Keel Scales |      |      |      |     |     |     | Average |       |
|------------|------|-----------------------------------|------|------|-----|-----|---------|-----------------------|------|------|------|-----|-----|-----|---------|-------|
|            |      | 55                                | 56   | 57   | 58  | 59  |         | 13                    | 14   | 15   | 16   | 17  | 18  | 19  |         | 20    |
| Dec.....   | —    | 3.7                               | 36.9 | 52.5 | 7.0 | —   | 56.63   | 5.6                   | 28.8 | 46.4 | 17.6 | 1.2 | —   | 0.4 | —       | 14.82 |
| Jan.....   | —    | 4.9                               | 42.6 | 47.5 | 4.9 | —   | 56.52   | 4.2                   | 35.2 | 46.5 | 13.0 | 0.5 | —   | 0.2 | 0.2     | 14.73 |
| Feb.....   | 0.35 | 3.5                               | 38.3 | 53.7 | 4.2 | —   | 56.58   | 6.3                   | 31.3 | 49.7 | 11.7 | 0.7 | —   | 0.3 | —       | 14.70 |
| 1951/52... | 0.11 | 4.1                               | 39.8 | 50.8 | 5.2 | —   | 56.57   | 5.3                   | 32.3 | 47.5 | 13.8 | 0.7 | —   | 0.3 | 0.1     | 14.74 |
| 1950/51... | —    | 2.6                               | 42.6 | 48.5 | 6.0 | 0.3 | 56.58   | 3.2                   | 29.8 | 49.3 | 15.9 | 1.6 | 0.2 | —   | —       | 14.83 |

<sup>1)</sup> Among the 942 spines 30, or 3.18%, with one or more fused vertebrae and 2, or 0.21%, with damaged vertebrae. These 32 spines have been eliminated from our calculations.

This remarkable increase can be explained by the better rigging of the herring trawl and by the fact that during last season, the greater part of the largest trawlers were fishing with the "bull-net".

The average catch per fish day for 1 H.P. developed for a trawler fishing individually reached 26.1 Kg. and was 43.3 Kg. for a "bull-net" trawler, or 66% higher.

It is scarcely necessary to say that this good result will be a stimulation for those who up to now hesitated to use the "bull-net" and it may be expected that this fishing method will meet with still more success in the future.

## B. Biology.

Twelve samples were investigated. The results are shown in Tables 25 to 27.

The average length of the herring was the same as in 1950—51, viz., 25.4 cm. During December this average reached its highest level with 25.6 cm. and its lowest in February with 25.3 cm. The average weight of the herring was 109 gr. It is also during December that the highest weight was recorded, viz. 114 gr.

Concerning the percentage distribution of the year-classes, we find that the three- to six-year-old herrings were never so well represented in the catches, viz. with 84.0%.

| Year-Class       | 1948 | 1947 | 1946 | 1945 |
|------------------|------|------|------|------|
| Age (Years)..... | 3    | 4    | 5    | 6    |
| Percentage.....  | 19.7 | 26.6 | 23.7 | 14.0 |

The vertebral average was 56.57. Its maximum was during December with 56.63 and its minimum in January with 56.52. The high vertebral average observed during December, shows that the "Channel Herring" had then already penetrated into the southernmost area of the North Sea.

Among the 942 stomachs examined only 8, or 0.84%, were found to have some contents, which for the greater part consisted of remains of copepods.

## C. Forecasts for the Campaign 1952—53.

Considering the exceptionally good representation of the youngest generations in the catches of last season, it may be expected that during the next season, they will also be very well represented and in this manner ensure dense herring concentrations.

In consequence, if the herring concentrations present themselves when favourable hydrological conditions prevail and the exploitation is not hindered through bad weather conditions, we may expect the spent-herring campaign 1952—53 to give satisfactory results.

CH. GILIS.

## Hareng du Sud de la Mer du Nord et de la Manche Orientale.

### Campagne de Pêche 1951—52.

#### I. Déplacement de la Pêcherie. Rendements.

##### a) Drifters.

Les premières captures faites à bord des unités artisanales armées au filet dérivant et basées au port de Boulogne eurent lieu au large d'Étaples, vers le 25 Octobre.

La pêche du hareng au filet dérivant se poursuivit en Novembre et Décembre: elle fut interrompue à la fin de ce dernier mois, en raison des fortes tempêtes et les bateaux-désarmèrent dès le début de Janvier; ce désarmement s'effectua trop tôt, semble-t-il, car à la fin de Janvier on signalait encore la présence de bancs de harengs dans le Pas de Calais, au large de Boulogne; quelques drifters anglais à cette époque et dans cette région firent, en effet, des captures appréciables.

##### b) Chalutiers.

Ce n'est guère que vers le 6/7 Novembre que la flottille de chalutiers se concentra sur le

Sandettié pour y effectuer la pêche du hareng «plein» et «bouvard» qui se rassemble toujours en cet endroit, à cette époque de l'année. Cette pêche donna lieu à des sorties en général courtes (24 à 48 heures) et à des apports variables, mais dans l'ensemble satisfaisants, surtout en ce qui concerne les bateaux pourvus de sondeurs enregistrant les bancs de poissons (appareils français: Sadir-Carpentier, Scam; appareil allemand: Atlas-Werke). Les rendements des unités pourvues de ces engins auraient, de l'avis des usagers, augmenté de 25% environ.

La technique de pêche se trouve par ailleurs modifiée du fait que le temps consacré au repérage des bancs de harengs devient beaucoup plus important que celui consacré à la pêche proprement dite puisqu'il suffit que le chalut passe convenablement pendant quelques minutes dans un banc de harengs pour en capturer jusqu'à 10 ou 15 tonnes.

Pour 48 heures de pêche au Sandettié les apports des grands et moyens chalutiers ont été fréquemment de l'ordre de 40 à 80 tonnes.

A la fin de Novembre les bancs de harengs étaient clairsemés sur le Sandettié et à partir de cette époque la flottille de pêche se concentra sur les fonds de l'Ailly, en Manche Orientale; d'importantes captures de harengs pleins et bouvards s'effectuèrent sur ces fonds en Décembre. A la fin du mois, cependant, la pêche fut grandement contrariée par le mauvais temps.

A partir de Janvier un certain nombre d'unités ont procédé à la pêche du hareng guai sur les Bancs de Flandre (Ruytingen, West-Dyck) mais cette pêche n'a pas revêtu une grande importance; elle a fait place, vers la fin de Janvier, à une pêche de harengs et de merlans dans la région comprise entre le North Hinder et le Silver Pit, pêche qui s'est poursuivie en Février; les apports (harengs et merlans) par sortie de 4 à 5 jours et par chalutier de moyen tonnage étaient de 10 à 20 tonnes.

En résumé la saison de pêche du hareng plein et bouvard (stades V et VI) — principalement en Novembre sur le Sandettié — fut marquée par des apports satisfaisants qui ne paraissent pas sans relation avec l'emploi d'engins perfectionnés tels que les sondeurs à ultrasons qui commencent à être utilisés à bord d'un certain nombre de chalutiers.

L'importance de la campagne du hareng guai sur les Bancs de Flandre est restée secondaire.

## II. Conditions Hydrologiques.

Les salinités et températures suivantes ont été observées sur les lieux de pêche ou à proximité. (Observations faites au cours de sorties à bord des chalutiers).

| Date     | Position E. Gr.   | Profondeur | Salinité ‰ | Température °C. |
|----------|-------------------|------------|------------|-----------------|
| 25/11 51 | 51°08'—1°51'10"¹) | surf.      | 34.74      | —               |
| 26/11 51 | 51°10'—1°57'¹)    | 30 m.      | —          | 12°75           |
| 26/11 51 | 51°12'—2°04'¹)    | surf.      | —          | 12°50           |
| 27/11 51 | 50°13'—0°41'²)    | surf.      | 34.76      | 12°75           |
| 18/12 51 | Sandettié.....    | surf.      | 35.01      | —               |
| 24/1 52  | 51°02'—1°55'³)    | surf.      | 34.05      | —               |

¹) Entre les bancs Sandettié et Ruytingen.

²) Ailly.

³) Bat. feu «West Dyck».

## III. Observations Numériques.

La moyenne vertébrale des échantillons étudiés et groupés suivant leur provenance n'appelle pas de remarques spéciales, sauf en ce qui concerne la valeur relativement faible des échantillons en provenance du Sandettié (Sandettié: 56.42; Manche Orientale: 56.63; Bancs de Flandre: 56.59).

La taille moyenne a augmenté par rapport à l'année dernière.

## IV. Composition du Stock.

Nous avons noté au cours des deux années précédentes (1949—50 et 1950—51) l'abondance relative des harengs de 3 ans dont le pourcentage atteignait environ le double du pourcentage normal. Un phénomène analogue est à nouveau constaté cette année: la classe des harengs de 3 ans (cl. 1948) atteint 23% du stock, alors que le pourcentage normal de cette classe est de 15%, et la moyenne 1926—37 était 12.3%.

La classe des harengs de 4 ans (cl. 1947), très bonne l'année dernière, ne s'est pas maintenue dans sa valeur relative: elle atteint *seulement* 24% du stock, c'est-à-dire à peine le pourcentage normal de cette classe.

La classe des harengs de 5 ans reste, comme l'année dernière, voisine de la moyenne, ainsi que celle des harengs de 6 ans:

Hareng de 5 ans: 21.8. Moyenne 22.4%.

Hareng de 6 ans: 16.0. Moyenne 15.6%.

## Matériel 1951—52.

**Taille.** (Distribution des nombres ramenée au cm. inférieur; moyenne corrigée par addition de 0.5 cm.)

| cm.         | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | Total | Moyenne |
|-------------|----|----|----|----|----|----|----|----|-------|---------|
| Sandettié   | 12 | 43 | 37 | 66 | 92 | 43 | 7  | —  | 300   | 25.63   |
| Manche Or.  | 10 | 32 | 33 | 66 | 82 | 48 | 17 | 2  | 290   | 25.88   |
| Bes. de Fl. | 3  | 12 | 13 | 23 | 38 | 30 | 10 | —  | 129   | 26.13   |

**Age.** (Ensemble du stock).

| Classe | 1948 | 1947 | 1946 | 1945 | 1944 | 1943 | 1942 | 1941 | 1940 |
|--------|------|------|------|------|------|------|------|------|------|
| Ans    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 11   |
| %      | 23.1 | 24.3 | 21.8 | 16.0 | 6.7  | 3.6  | 3.3  | 1.0  | 0.3  |

N = 701

**Moyenne vertébrale.** (Distribution des nombres).

| Vertèbres   | 53 | 54 | 55 | 56  | 57  | 58 | 59 | Total | Moyenne |
|-------------|----|----|----|-----|-----|----|----|-------|---------|
| Sandettié   | 1  | 1  | 12 | 136 | 127 | 4  | —  | 282   | 56.42   |
| Manche Or.  | —  | 2  | 6  | 102 | 159 | 14 | 1  | 284   | 56.63   |
| Bes. de Fl. | —  | —  | 5  | 50  | 67  | 7  | —  | 129   | 56.59   |

Les autres classes sont au dessous de la moyenne ou égales à celle-ci.

La composition du stock se rapproche dans l'ensemble de la moyenne, la seule exception notable étant la classe des harengs de trois ans qui dépasse cette moyenne des 3/5.

Il est nécessaire, pour donner une interprétation des faits constatés, de tenir compte de la composition du stock au cours des précédentes années: cette interprétation fera l'objet d'une note spéciale.

J. ANCELLIN.

### Influence de la Pêche sur la Composition du Stock de Hareng dans le Sud de la Mer du Nord et en Manche Orientale.

Les recherches entreprises au Laboratoire de Boulogne s/ Mer nous ont permis de suivre, année par année, depuis 1945, la composition par classes d'âge du stock de hareng faisant l'objet de la pêche d'hiver des chalutiers bouillonnais dans le sud de la Mer du Nord et en Manche Orientale, principalement dans les secteurs du Sandettié, de l'Ailly et des Bancs de Flandre.

L'évolution qui s'est manifestée dans la composition de ce stock au cours des années 1945—52 mérite de retenir l'attention.

Si nous nous basons sur la composition moyenne du stock (représentée sur Figure 12 par des points) portant sur 12 années et établie d'après les travaux effectués au Laboratoire de Boulogne avant la guerre (cf. J. LE GALL, Rev. des Trav. Off. des Pêches, no. 42), nous

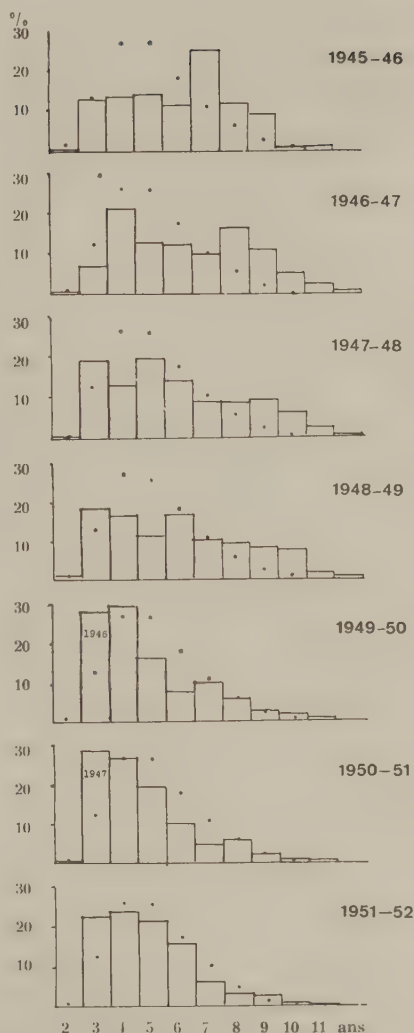


Figure 12. Composition du stock des harengs du sud de la Mer du Nord et de la Manche Orientale.

constatons en effet que les classes les plus âgées, importantes pendant les quatre premières années (1945—48), sont beaucoup moins bien représentées durant les trois dernières (1949—51). Inversement les classes jeunes sont beaucoup mieux représentées durant les trois dernières années.

Il semble difficile de considérer ce phénomène comme uniquement lié à des fluctuations d'ordre purement biologique. L'influence de la pêche paraît, en la circonstance, jouer un rôle prépondérant.



## Harengs du Sud de la Mer du Nord et de la Manche Orientale.

Tableau 28. Composition du Stock.

Pourcentages relatifs des classes d'âge de 1945 à 1952 et moyennes des classes de 1926—1937 (N = 18,927), de 1926—37 et de 1945—51 (N = 23,706).

| Ans      | 2   | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10  | 11  | + |
|----------|-----|------|------|------|------|------|------|------|-----|-----|---|
| 1945—46  | 0.2 | 12.8 | 13.8 | 14.1 | 11.6 | 25.1 | 11.8 | 9.0  | 0.6 | 1.0 |   |
| 1946—47  | 0.6 | 6.9  | 21.5 | 12.8 | 12.4 | 9.8  | 16.4 | 10.9 | 5.2 | 2.7 |   |
| 1947—48  | 0.3 | 19.2 | 12.7 | 19.5 | 13.9 | 8.7  | 8.3  | 8.9  | 5.7 | 2.2 |   |
| 1948—49  | 1.0 | 18.0 | 16.1 | 10.9 | 16.5 | 9.9  | 9.0  | 8.0  | 7.3 | 2.5 |   |
| 1949—50  | 0   | 27.7 | 29.2 | 15.8 | 7.2  | 9.8  | 5.4  | 2.3  | 1.5 | 0.7 |   |
| 1950—51  | 0.2 | 28.8 | 26.7 | 19.6 | 10.1 | 4.7  | 5.8  | 2.2  | 0.6 | 0.5 |   |
| 1951—52  | 0   | 23.1 | 24.3 | 21.8 | 16.0 | 6.7  | 3.6  | 3.3  | 1.0 | 0.3 |   |
| 1926—37  | 0   | 12.3 | 26.2 | 25.8 | 17.4 | 10.3 | 5.2  | 2.0  | 0.6 | 0.1 |   |
| 1926—37) | 0.1 | 15.0 | 24.1 | 22.4 | 15.6 | 10.4 | 6.4  | 3.6  | 1.5 | 0.6 |   |
| 1945—51) |     |      |      |      |      |      |      |      |     |     |   |

On peut admettre, en effet, que pendant la guerre, le stock fut peu exploité; l'importance des vieilles classes qui avait peu à peu augmenté<sup>1)</sup> a continué à se manifester quelque temps encore après les hostilités; puis, la pêche s'intensifiant et absorbant une grande partie des harengs adultes, le pourcentage des jeunes classes se trouva favorisé — notamment celui des harengs de 3 ans qui font, chaque année, leur première apparition sur les fray-

<sup>1)</sup> Les travaux de CH. GILIS (Ostende) montrent l'importance progressive des classes âgées, à partir de 1941, pour les harengs des Bancs de Flandre.

ères du sud de la Mer du Nord et de la Manche Orientale. Ainsi s'expliqueraient les modifications observées dans la répartition des classes d'âge.

Au point de vue des conséquences économiques de ce phénomène nous devons constater que le stock 1951—52, en particulier, se rapproche précisément du stock moyen. Nous retrouvons en quelque sorte, à présent, la composition qui prévalait avant la guerre: celle d'un stock comportant un prélèvement dû à la pêche. Cette situation qui met en lumière l'influence de la pêche sur les bancs de harengs constituerait un avertissement, sans plus, si elle ne se trouvait aggravée par la constatation suivante: deux années de suite des classes de harengs de 3 ans apparues comme très importantes (classes 1946 et 1947) atteignaient tout juste le pourcentage moyen l'année suivante (harengs de 4 ans). Le fait que des classes de jeunes harengs ne gardent pas leur importance relative d'une année sur l'autre laisse supposer qu'elle se trouvent en quelque sorte décimées par des prélèvements considérables.

Ces résultats indiqueraient que la limite d'une exploitation rationnelle serait atteinte pour le hareng du sud de la Mer du Nord et de la Manche Orientale.

J. ANCELLIN.

## C. Skagerak, Kattegat, Belt Sea and Baltic.

### YOUNG STAGES

#### The Density and Distribution of Larvae.

Quantitative fishing with the 2 m. ring-trawl carried out from S/S "Biologen" during March, i.e., in order to locate the spawning grounds of the winter herring, showed that in the northernmost Kattegat there were many newly hatched larvae of winter-spawning herrings. Fishing with the ring-trawl during Apr.-May also revealed the presence of many larvae of winter spawners in the Belt Sea and western Baltic.

In the northern and central Kattegat the numbers of larvae of autumn spawners caught in the ring-trawl during February-March were quite large, obviously in accordance with the about normal quantities of these larvae caught in the same region during the autumn of 1950. In contrast, very few larvae of autumn spawners were found in the Belt Sea in the spring of 1951 which was in accordance with the catching of but few larvae of those herring there in October.

AAGE J. C. JENSEN.

## COMMERCIAL FISH

## The Skagerak and Northern Kattegat.

## Young Herring for Processing.

Racial analyses of samples of young herring caught together with sprats, small whittings and other species in the Skagerak near Skagen and in the northernmost Kattegat, to be used for processing, gave the following results:

| Date            | No. of samples | Mean length cm.     | V.S.        | V.P.  | K <sub>2</sub> |
|-----------------|----------------|---------------------|-------------|-------|----------------|
| 0 rings         |                |                     |             |       |                |
| 6/12 50-4/4 51  | 8              | 11.3                | 56.47 (769) | 23.84 | 14.92 (837)    |
| 13/1—15/3 51    | 2              | 13.0                | 56.65 (248) | 23.89 | 14.50 (222)    |
| 13/2 51.....    | 1              | 13.3                | 56.45 (207) | 23.74 | 14.62 (223)    |
| 1/3 51.....     | 1              | 11.9                | —           | —     | 14.42 (181)    |
| 16/7—18/7 51    | 3              | 6.9                 | 56.34 (188) | 23.98 | 14.82 (150)    |
| 3/8 51.....     | 1              | ca. 9 <sup>1)</sup> | 56.49 (187) | 23.64 | 14.44 (201)    |
| 1 ring.         |                |                     |             |       |                |
| 6/12 50-13/2 51 | —              | 18.7                | 56.25 ( 40) | 23.65 | 14.98 (43)     |

<sup>1)</sup> Mean length of the herring investigated was 10.9 cm.

In 8 of 12 samples of young herring caught during the winter season of 1950—51, the 0-group herring were typical autumn spawners from the north-western North Sea.

In 2 of these samples, caught 4. and 6. March near the Hirtsholmene off Frederikshavn, only the K<sub>2</sub> were counted; the means were 14.84 (107) and 14.97 (34) respectively. Although therefore they might seem to have been pure autumn spawners from the North Sea they may have included a few herring with a lower K<sub>2</sub>, since a mixture of herring races with different means of K<sub>2</sub> was found in a third contemporary sample from about the same place. In this third sample, K<sub>2</sub>, which was again the only character counted, was 14.42 (184). In all these three samples together, the K<sub>2</sub> for the smaller herrings, of 9—11 cm. length was 14.83 (204) but for the larger herrings, of 12—14 cm. length, K<sub>2</sub> was 14.30 (67).

In two samples from north of Skagen, 13. January and 15. March 1951, which also had a rather low K<sub>2</sub> of 14.50, the racial characters show that there the autumn spawners from the western North Sea were mixed with winter spawners from the northern Kattegat or possibly with winter or spring spawners from the Norwegian or the Scottish coasts; it cannot be decided which of these latter two races is the component in the mixture, because both lie

on the "mixing line" if they are entered in a V. S.-K<sub>2</sub> diagram<sup>1)</sup>.

Norwegian winter spawners are the less likely to be a component in the mixture, because they seem to have a comparatively high K<sub>2</sub> according to the sample analysed (see p.140), but this is the only sample analysed for both V. P. and K<sub>2</sub> since the great change of the racial characters occurred.

The sample from 13. February 1951 has the same V. S. and K<sub>2</sub> as the Minch autumn spawners investigated by Wood (Fish. Bd. Scetl., Sci. Invest., III, 1936, p. 51) but it must be more likely that these herring are mixtures of races spawning at places nearer to Denmark than the Minches even though it has not been possible to definitely name the constituents.

The 1-ringed herring caught together with the 0-ringed during the winter were comparatively few, and the small number analysed makes it impossible to decide with certainty as to the race to which they belonged. Autumn spawners from the North Sea seem to have constituted the major part of these herring, as is normally the case in this area.

The fat content was determined by the Technological Laboratory of the Ministry of Fisheries. It was 5.9% in the sample taken on 13. January, which consisted of a mixture of autumn spawners from the western North Sea and winter spawners, but in the other samples of a similar mixture on 15. March it was 1.0%. In the sample of autumn spawners taken on 6. December 1950 it was 3.4%, but in the other samples in December 1950 and February 1951 it was 2.0—2.7% and in a sample in April 1951 it was 1.0%.

During the summer months there was heavy fishing along the coasts of northern Jutland, at 2—4 m. depth. The lengths of fish in catches of a cutter and of the motorboat "Havkatten", from between Hals and Frederikshavn 16.—18. July, indicated that they must have been the young of autumn spawners (see the table), and the racial characters indicated that they were autumn spawners from the eastern North Sea. In a sample in August, caught by shore-seine at Vigsø to the east of Hanstholm, the mean length was greater than that of the group of autumn spawners could possibly have been, but the catch must have been selected by the implement for which a minimum mesh size of

<sup>1)</sup> JENSEN, AAGE J. C.: Migrations of the herring in the waters round Denmark. Rapp. et Proc.-Verb., Vol. 128, 1951.

**Table 29. Racial Characters of Herring caught for Consumption in the eastern Skagerak.**

Numbers are given in brackets

| Date, year                    | Maturity | Length,<br>cm. | V. S.       | V. P. | K <sub>2</sub> |
|-------------------------------|----------|----------------|-------------|-------|----------------|
| 3/12, 14/12<br>1950 . . . . . | I        | 17-24          | 56.60 (228) | 23.70 | 14.52 (228)    |
| 14/12 1950 . . .              | II-III   | 20-28          | 56.45 ( 38) | 23.95 | 14.97 ( 38)    |
| 30/1 1951 . . .               | I-IV     | 21-28          | 56.26 ( 35) | 23.80 | 14.63 ( 35)    |
| 4/4 1951 . . .                | I-II     | 20-26          | 56.74 (141) | 23.94 | 14.56 (135)    |
| 14/12 1950,<br>30/1, 4/4 1951 | VII-VIII | 21-31          | 56.44 (243) | 23.85 | 15.00 (239)    |
| 9/7 1951 . . .                | I-II     | 22-30          | 56.40 ( 54) | 23.80 | 14.48 ( 46)    |
| 9 7 1951 . . .                | III-VII  | 23-31          | 56.48 (103) | 23.99 | 15.10 ( 96)    |

20 mm. from knot to knot is in force. The V.S. indicate that the fish were autumn spawners from the western North Sea, but the K<sub>2</sub> was so low as to be comparable only to that found in samples of the autumn spawning Minch herring investigated by H. Wood (Fish. Bd. Sct'l., Sci. Invest., III, 1936, p. 51). As stated earlier, it is improbable that groups of the Minch herring should occur in great numbers on the Skagerak coast, and we must presume that these occurring here were the young of some autumn spawners from some nearer grounds, although we do not know of any nearby spawning community with the observed racial characters.

#### Herring for Consumption from the eastern Skagerak.

During the winter season 1950—51, 5 samples of herring caught by Danish cutters in the eastern Skagerak were examined; four were caught by floating trawl and one by otter-trawl. The herring caught were of 18—31 cm. length; in the latest catch, on 4. April, which was taken by floating trawl, 70% of the total weight of the catch was contributed by various other round fish and, of the otter-trawl catch, two thirds consisted of fish for processing, including some sprats.

The maturities varied from one catch to another but, on the average, 47% were herring of length 18—23 cm. and of maturity I, 12% were of maturity II, 3% were of maturities III—VI, and 38% were spents and recovering

spents. The 12% of maturity II were mostly young fish which had not spawned before; the 3% of maturities III—VI were about normal; but the 38% spents compare with about 62% in both of the previous seasons 1949—50 and 1948—49. It would seem that the density of young immature fish had increased.

The racial characters (see Table 29) of the spents and recovering spents show that they were typical autumn spawners from the north-western North Sea—as is normally the case. The herring of maturity I in the December samples were mostly of this race mixed with winter herring with a high V.S.; these winter spawners were quite numerous in the sample of 4. April. In small samples of immature herring taken on 14. December and 30. January the herring seemed to be autumn spawners from the north-western North Sea or mixtures of these and coastal winter or spring spawners from the waters inside the Skaw.

In July 1951 a sample of trawl-caught herrings consisted of about 65% of maturity II—III and 20% of maturity V. The racial characters show (see Table 31) that the few herrings of maturities I—II had the racial characters of the Minch autumn herring, but most probably they were a mixture of races. The almost mature herrings were typical autumn spawners from the north-western North Sea.

#### The Limfjord.

In two samples of pound-net herring taken in the spring spawning season, in April 1951, the herrings were 22—31 cm. long and practically all were of maturities IV—VII. The racial characters of these were V.S.: 55.85, V.P.: 23.78, K<sub>2</sub>: 14.15, i.e. typical Limfjord spring spawners.

55% of the herring were of the 1947 year-class, 26% of the 1946 year-class and 10% of the 1945 year-class.

#### The Central and Southern Kattegat and the Belt Sea.

##### Herring of the 0-Group.

During the summer of 1951 the quantities of small herring occurring along the Kattegat

**Table 30. Samples of 0-ringed Herrings from the southern Kattegat and the Belt Sea.**

| Locality . . . . .       | At Djursland | Roskilde fjord | Off Kerteminde    | Southern Little Belt  | S. of Als  |
|--------------------------|--------------|----------------|-------------------|-----------------------|------------|
| Date, year . . . . .     | 13./VII. 51  | 18.-20./IX. 51 | 22./I., 7./II. 51 | 23./X. 50—14./III. 51 | 24./X. 50  |
| Mean length, cm.         | 6.6          | 6.3            | 13.6              | 13.3                  | 8.7        |
| V.S. . . . . .           | 56.40 (42)   | 55.80 (213)    | 56.13 (361)       | 55.85 (416)           | 55.25 (96) |
| V.P. . . . . .           | 24.22 (41)   | 23.55 (198)    | 23.87 (361)       | 23.72 (416)           | 23.16 (96) |
| K <sub>2</sub> . . . . . | —            | 14.07 (336)    | 14.36 (253)       | 14.08 (455)           | 13.62 (90) |



**Table 31. Herring caught for Consumption in the Southern Kattegat and the Belt Sea.**

G = Great Belt, K = Kattegat, L = southern Little Belt,  
W = Western Baltic, P = 10 Pound net, PS = Purse seine,  
T = Trawl

**A. Maturities.**

| No. | Locality                    | Gear   | Date,<br>year  | Stages |        |      | VII-VIII |
|-----|-----------------------------|--------|----------------|--------|--------|------|----------|
|     |                             |        |                | I-II   | III-IV | V-VI |          |
| 1   | At the Kobbergrund. . . . . | K T    | 25/10, 3/11 51 | 16     | 11     | 43   | 30       |
| 2   | N.E. of Anholt              | K T    | 14/3 51        | 22     | 6      | 48   | 25       |
| 3   | S.E. —                      | K T    | 5/4 51         | 34     | 56     | 7    | 3        |
| 4   | Roskilde fjord. . . . .     | (K) PS | 13/12 50       | 43     | 55     | 2    | 1        |
| 5   | N. Seeland. . . . .         | K P    | 7/5 51         | 2      | 92     | 2    | 4        |
| 6   | Off Kerteminde. . . . .     | G T    | 30/1 51        | 80     | 12     | 6    | 3        |
| 7   | S. of Als. . . . .          | W T    | 24/10 50       | 64     | 16     | 8    | 14       |
| 8   | At Kelstrup. . . . .        | L P    | 13/12 50       | 79     | 5      | 5    | 11       |
| 9   | S. Little Belt. . . . .     | L T    | 1/2 51         | 65     | 13     | 7    | 15       |
| 10  | Flensborg fjord. . . . .    | W T    | 13/4 51        | 41     | 31     | 16   | 12       |
| 11  | At Assens. . . . .          | L P    | 27/2 51        | 7      | 18     | 85   | 0        |
| 12  | S. of Als. . . . .          | W P    | 11/4 51        | 1      | 18     | 57   | 21       |
| 13  | At Helnæs. . . . .          | L P    | 20/4 51        | 1      | 1      | 27   | 68       |
| 14  | At Spodsbjærg               | G P    | 20/10 50       | 2      | 3      | 85   | 11       |

**B. Racial Characters**

(in brackets: numbers investigated).

| No.      | Mat.              | Length,<br>cm. | V.S.        | V.P.  | K <sub>2</sub> |
|----------|-------------------|----------------|-------------|-------|----------------|
| 1        | I-IV. . . . .     | ca. 24         | 56.06 ( 61) | 23.93 | 14.32 ( 54)    |
| 1        | V-VI. . . . .     | ca. 26         | 56.22 (102) | 24.26 | 14.37 (102)    |
| 1        | VII-VIII. . . . . | ca. 28         | 56.00 ( 59) | 24.24 | 14.33 ( 58)    |
| 2        | I-III, VII-VIII   | 21-30          | 56.28 ( 75) | 24.08 | 14.58 ( 73)    |
| 2        | IV-VI. . . . .    | ca. 26         | 55.92 ( 80) | 23.60 | 14.11 ( 79)    |
| 3        | I-VIII. . . . .   | ca. 22         | 56.10 (175) | 23.79 | 14.40 (169)    |
| 4        | I-VIII. . . . .   | ca. 21         | 55.58 (174) | 23.39 | 14.12 (169)    |
| 5        | IV-VI. . . . .    | ca. 22         | 56.06 (173) | 23.49 | 14.24 (171)    |
| 6        | I-III. . . . .    | ca. 21         | 55.75 (151) | 23.68 | 14.19 (149)    |
| 7        | I-II. . . . .     | ca. 21         | 55.84 (116) | 23.53 | 14.02 (110)    |
| 8        | I-III. . . . .    | ca. 22         | 55.95 (142) | 23.85 | 14.33 (137)    |
| 8        | IV-VIII. . . . .  | ca. 24         | 56.00 ( 33) | 24.00 | 14.16 ( 32)    |
| 9        | I-III. . . . .    | ca. 21         | 55.76 (123) | 23.38 | 14.21 (119)    |
| 9        | IV-VIII. . . . .  | ca. 23         | 55.67 ( 52) | 23.56 | 14.24 ( 49)    |
| 10       | I-II. . . . .     | ca. 22         | 55.85 ( 89) | 23.31 | 14.26 ( 93)    |
| 11-12-13 | IV-VIII           | ca. 25         | 55.82 (406) | 23.38 | 14.35 (396)    |
| 14       | IV-VIII. . . . .  | ca. 23         | 55.93 (164) | 24.32 | 14.30 (161)    |

coast of Jutland and in the Roskilde fjord were larger than usual. Samples were caught by the motorboat "Havkatten" on the eastern coast of Djursland and in the Roskilde fjord. Small herring caught for processing in the Great Belt off Kerteminde, in the southern Little Belt between Lyø and Als and in the western Baltic south of Als were also investigated (see Tab. 30).

The herring fished during the winter 1950—51 in the southern Little Belt were ordinary Belt Sea spring spawners.

The herring fished off Kerteminde were the young of coastal autumn spawners from the Kattegat.

The herring found at Djursland in July 1951 seem to have been autumn spawners from the Kattegat or possibly from the North Sea but unfortunately the sample was very small and it was impossible to count the K<sub>2</sub> on account of bad preservation; perhaps this was also the cause of the very high V.P.

The herring in the Roskilde fjord were ordinary Belt Sea spring herring like those fished, e.g. in the Little Belt during the winter.

The fat content of the herring caught in the southern Little Belt varied between 1.0 and 5.6%; as is often the case it was highest in the largest of the small herrings. Off Kerteminde it was 3.9—4.7%.

**Herring for Consumption from the Central and Southern Kattegat and the Belt Sea.**

Two samples of herring from the eastern Kattegat at the Kobbergrund between Anholt and Læsø, caught by trawl by Swedish cutters 25. October and 3. November 1951, were of fish 21—32 cm. long. About 80% were full, spawning or newly spents; they were Kobbergrund herring, but it may be mentioned that these herrings had a somewhat lower V.S. than was presumed by A. C. JOHANSEN when he established this race on the basis of immature and spent herring. The material for determining the racial characters of the immature herring, which were mostly of about 25 cm. length, was rather scanty, but it seems that they were coastal herring from the Kattegat. The fat content of the mature herring was 8.6%, and that of the spents was 4.1%.

Of the herrings fished in March-April 1951 at Anholt, those in a sample from south-east of Anholt were mainly immature or maturing, whereas in a sample from north-east of Anholt about half of the herrings were full, a quarter were immature and a quarter were spents or recovering spents. The racial characters (see Table 31 B) show that most of the herring in the first-named sample were coastal autumn spawners from the Kattegat whereas in the other samples the immatures and the spents were Kobbergrund herring mixed a little with herrings with higher V.S. and K<sub>2</sub> and a lower V.P. and the full herrings were Kattegat and northern Belt Sea spring spawners.

The immatures in the first-named sample had very low fat contents of 0.5—0.7%,

whereas the maturing and full herring in both samples contained 4.5–5.5% fat and the spents 2.8% fat.

In the Roskilde fjord, because the size of the stock fluctuates so much, a winter and spring fishery is carried out in series of years separated by intervals when no herring are fished. In a sample (4) the herring were mostly 3 and 4-ringed i.e. of year-classes 1946 and 47, and they were immature or maturing. The racial characters (see Table 31B) were considerably different from those of the spring spawners at North Seeland, which were investigated in May 1951. In the inner part of Roskilde fjord the salinity is about 10–12‰, and it is seen that the spawning community there had a comparatively low number of vertebrae, which is characteristic of enclosed, brackish-water regions. The stock does not stay there; of the herring tagged at Copenhagen in November 1950, one full fish was recaptured in the Roskilde fjord in May 1951 during the spawning season, and another was caught in the northern part of the fjord in August when it was recovering. Of the herrings tagged on the North Seeland coast of the Kattegat in May 1951, one was recaptured a fortnight later in the Roskilde fjord and was full.

The fat contents of these herring caught in winter in the Roskilde fjord are very high, 6.5% in those of maturity I, and about 11.5% in the maturities II–V.

The spring spawning herring at North Seeland in May (see Table 31, A and B) were mainly full. About 70% were 2-ringed of the 1949 year-class, whereas the 1947 year-class predominated in the spring of the previous year in a sample of herring with the same racial characters (comp. Ann. Biol. VII p. 150, sample 6). The fat contents of the full herrings, about  $2\frac{1}{2}$ –3%, were rather low.

Of the trawled herring caught in the Great Belt off Kerteminde i January 1951 (sample 6) the majority were immature, 1-ringed, Belt Sea winter spawners; about 15% were maturing, full, spawning or spents, which had about the same racial characters as the immatures. Immature herrings, mostly two-year-olds and of lengths 20–23 cm., were caught together with a minor part of maturities III–VIII, in trawls and pound-nets in the southern Little Belt during the winter and spring 1950–51, and were found also south of Als where Danish trawling was prohibited (see Table 31 A, samples 8, 9, and 10). All of these herring were

Belt Sea winter spawners. During recent years the winter spawners seem to have become more and more abundant in the Belt Sea. The fat contents of the immature fish were about 7%.

Some samples from important spawning grounds both of these herrings and of the spring spawners, at the south-west of Funen (samples 11, 12, and 13), show how the maturity changed during the spawning season, and that practically all herrings caught in these winter and spring fisheries were Belt Sea winter spawners.

In October 1950 a sample (No. 14) from a pound-net east of Langeland was investigated. Most of the fish were full, spawning or spents and their racial characters corresponded to those of the ordinary Belt Sea autumn spawners. They were mostly rather young: 60% were only 2 years old (19–23 cm. long), confirming the finding of the 1949–50 investigations which showed that 0-ringed fish of this race were more abundant than had been the case for many years, and that therefore there was a hope of a recovery of the stock of autumn spawners (see Ann. Biol., VII, p. 149). The fat content of the full herring of length 20 cm. was only about 3% and of the 25 cm. fish about 8%.

A sample of herrings caught south of Als (in the western Baltic) by trawl 24. October 1950 consisted mostly of 0-ringed herring (No. 7); they were mostly immature Belt Sea spring spawners.

#### Tagging of Herring in the Limfjord and the Belt Sea.

Taggings with external tags were carried out at Hølnæs, south-west Funen, and at Hvalpsund in the Limfjord, in April, and at Hundested, north Seeland, in May 1951. The herring were taken from catches in pound-nets and the tags used were the Lea tag and red and blue Alcatene (stiff plastic) tags fastened with nylon thread. The percentages of recoveries were as follows:

| Locality             | Number tagged | % recaptured |            |
|----------------------|---------------|--------------|------------|
|                      |               | first month  | first year |
| S.W. Funen . . . . . | 264           | 10           | 19         |
| N. Seeland . . . . . | 240           | 28           | 32         |
| Limfjord . . . . .   | 297           | 35           | 38         |

The results are not to be compared directly because in the course of the taggings the method was varied in different ways in order to improve it.

From the tagging at Hølnæs most recaptures have been from the southern Little Belt and

the western Baltic but some have been from the northern Belt Sea and one from the Fladen Ground. From north Seeland taggings most recaptures have been from the Isefjord and the north coast of Seeland, with some from other places in the Kattegat, the Belt Sea and western Baltic and one from Swinemünde, east of Rügen. It is evident that some of the North Sea autumn spawners stray into the Belt Sea; this was found also from the tagging in 1949.

From the tagging in the Limfjord, most recoveries have been from this fjord; 3 have been recaptured in the Skagerak, which confirms the conclusion drawn from the 1949 taggings about wandering of herring between these areas.

The percentage recaptured in the first year over a shorter period provides an underestimation of the fishing intensity, but a more accurate estimate can be made from returns when most of the recaptures are taken shortly after the tagging; the longer the time elapsing between tagging and recapture the greater will be the number of fish losing their tags or dying as a result of the tagging.

### The Sound and the Baltic Proper.

#### Size, Age, Maturity and racial Characters.

Two samples of pound-net herrings were caught in November 1950 in Køge Bay. One of these caught north of Stevns, consisted partly of 0-group herring about 14 cm. long and partly of 1–6-ringed (mostly 1–4-ringed) herring about 20 cm. long. The other, caught at Copenhagen, contained mainly 2- and 3-ringed fish of length about 21 cm. The maturities of most of the herrings with more than 1 ring were from I–III or IV with a few of V and VII–VIII. The last-mentioned must naturally have been autumn spawners, but there were too few of them for a race determination to be made. The racial characters of the others are shown in Table 32. The 0-group herring, which had a rather high V.S. may have been spring spawners from the southern Belt Sea, while the immature and maturing herring were spring spawners from the southern part of the Belt

Sea or the Baltic proper. Spawning herrings with exactly the same racial characters have been caught at Rügen and investigated by HEINCKE, JOHANSEN and ALTNÖDER, and quite a number of the herring tagged contemporaneously with the fishing of the samples considered here have been recaptured at Rügen. Others have been recaptured in the western Belt Sea and some in the southern and central Kattegat and in the Belt Sea.

Two samples from Bornholm in July–August were investigated. Half of these herrings were young of maturities I–II and of length about 21 cm.; they were spring spawners of the type spawning at Rügen. The others were maturing or spent of length about 24 cm.; they may have been a mixture of the Rügen-type spring spawners and Bornholm autumn spawners (see Table 32).

**Table 32. Racial Characters of Herring caught in the Sound and at Bornholm.**

(In brackets: numbers investigated).

| Locality         | Maturity Rings   | V.S.        | V.P.  | K <sub>2</sub> |
|------------------|------------------|-------------|-------|----------------|
| Køge Bay . . . . | I . . . . . 0    | 55.76 (203) | 23.62 | 14.05 (144)    |
| — . . . . .      | I–IV . . . 1–5   | 55.61 (171) | 23.80 | 13.88 (174)    |
| At Bornholm . .  | I–II . . . . 1–8 | 55.51 (173) | 23.92 | 13.68 (167)    |
| — . . . . .      | III–VIII 1–7     | 55.68 (173) | 23.84 | 14.05 (144)    |

#### The Influence of the Temperature upon the Yield of the Fishery.

In August the temperature in the intermediate cold layer to the south-east of Bornholm was very low. At a station 15 miles east of Neksø worked by S/S "Biologen" 16. August, the temperature was only 2.8° at 40 m. depth. In this region herring were caught by trawl, but the nets which fish above the cold water layer got poor catches. To the east of Christiansø where the temperature of the intermediate cold water layer was high at about 4.5°, most of the herring were taken in nets. A similar apparent relationship between the catches and the temperature in the intermediate cold layer has also been observed in some former years.

AAGE J. C. JENSEN.



# Shellfish.

## INTRODUCTION

Contributions have been received from CH. GILIS, G. DUNCAN WAUGH, P. KORRINGA (2), J. AUDOUIN & R. LETACONNOUX. These papers give a good idea of the problems that have occupied the shellfish workers in the different countries in 1951. All these problems arose directly from the requirements of the industry.

In the contribution of GILIS a concise survey is given of the investigations carried out on the influence of the size of the mesh in the trawl on the size of the shrimp caught. This work is prompted by the fear that the catching of large quantities of small shrimp may cause overfishing, or perhaps has already caused it. This work is closely related with the Dutch statistical work on the catch of shrimp per unit effort which was reported in the Ann. Biol., 1950. The continuation of this investigation could not be published in the Annales for 1951, as the statistics were not ready in due time.

The paper of AUDOUIN & LETACONNOUX on *Chlamys varia* is the only one dealing with

Mollusca living under natural conditions, not protected by methods of culture.

Contributions by WAUGH and KORRINGA give a survey of the spatfall of oysters in 1951 in some parts of England and in the Netherlands. Investigations of this nature are very valuable for the oyster culture as they greatly assist the oystermen in finding the best time and place for laying out their spat collectors.

The great damage done by the parasite *Mytilicola intestinalis* in 1950 has induced many investigations in England, France, Germany and the Netherlands. Although *Mytilicola* is still present in all the areas in which it was noticed in 1950, it gave much less trouble in 1951 than it did in 1950, at least in the Netherlands. The distribution and frequency of the parasite, however, are followed closely as it is quite possible that a new outburst caused by favourable environmental conditions will lead again to great damage. KORRINGA's paper gives a survey of the work done in the Netherlands in 1951.

B. HAVINGA.

## CRUSTACEA

## Shrimp.

## L'Effet de Tamisage des Mailles du Chalut à Crevettes.

## Pêches expérimentales faites sur la Côte Belge.

Sur la côte belge la pêche crevettière constitue l'exploitation principale pour le petit pêcheur côtier.

La flottille crevettière belge compte au 1. Janvier 1951, 177 côtres ou canots demi-pontés. Tous sont à propulsion mécanique. Leur force motrice varie entre 9 et 77 CVX, en moyenne 47 CVX par bateau. En moyenne ils jaugeaient 17 TB par unité.

La production annuelle de crevettes est sujette à des fluctuations considérables. Ainsi, au cours de la période 1935—1939, elle se situait entre 4 et 2.6 millions de kilos. Après la guerre, soit de 1946 à 1950, entre 1.3 et 2 millions de kilos seulement.

La prise moyenne par heure de pêche pour un CV développé atteignait les valeurs suivantes:

| Période      | Poids, g. | An   | Poids, g. | An   | Poids, g. |
|--------------|-----------|------|-----------|------|-----------|
| 1935—39..... | 401       | 1946 | 309       | 1948 | 298       |
| 1946—50..... | 288       | 1947 | 355       | 1949 | 283       |
|              |           |      |           | 1950 | 228       |

C'est donc à partir de 1948 que nous constatons une nouvelle et sensible diminution de la prise moyenne par heure de pêche pour 1 CV développé. Cette diminution signifie incontestablement une régression très marquée du stock de la crevette sur la côte belge, au cours de la période envisagée.

Les causes de cette régression sont sans doute multiples.

Il est un fait que les conditions hydrologiques, suivant qu'elles ont été bonnes ou mauvaises au cours de la reproduction ou pendant le développement des larves, peuvent dans une large mesure favoriser ou contrarier le renouvellement des réserves de la crevette.

D'autre part, l'étude du contenu stomacal des poissons capturés dans le filet à crevettes, montre que plusieurs espèces sont très friandes de crevettes et en particulier le merlan, le tacaud, le rouget, la raie et le congre. Aussi, d'après le nombre de crevettes observées dans les estomacs, il faudrait admettre que lorsque ces poissons se présentent en masse dans la

zone côtière, ils sont capables de dévorer de quantités non négligeables de crevettes.

Les conditions hydrologiques et la présence de poissons ennemis de la crevette sont des phénomènes naturelles, contre lesquelles l'homme est impuissant.

Toutefois concernant la médiocrité du rendement de la pêche, il n'est pas exclu que le pêcheur aussi est en cause et c'est pourquoi nous avons porté notre attention sur le filet à crevettes, lequel étant donné l'étroitesse de ses mailles semble devoir détruire aussi de grandes quantités de crevettes immatures.

En effet, les mailles de cul du filet, en usage par les crevettiers, mesurent à peine 18 mm. lorsqu'elles sont étirées dans le sens de la longueur et mouillées.

Il est compréhensible qu'à travers de mailles si étroites, même les plus petites crevettes, une fois qu'elles sont prises dans le cul, ont peu de chances de pouvoir s'échapper encore. Dès lors elles sont détruites au détriment du stock de la crevette et sans aucun profit pour le pêcheur, puisqu'elles n'ont aucune valeur commerciale en Belgique.

C'est d'ailleurs ce que nous avons constaté dans le butin de nos pêches expérimentales qui contenaient à maintes reprises jusqu'à 50 et même 60% de crevettes en dessous de la taille vendable.

Nos investigations concernant la capacité de tamisage des mailles du filet crevettier ont commencé en 1949 et dès à présent elles comptent quatre expériences, à savoir:—

| Expérience | Largeur des mailles, mm. | H. de pêche effective | Poids de Crevettes, kg. |                  | % de Crevettes |                  | Crevettes commerciales p./heure de pêche, kg. |
|------------|--------------------------|-----------------------|-------------------------|------------------|----------------|------------------|-----------------------------------------------|
|            |                          |                       | Crevettes commerciales  | non-commerciales | commerciales   | non-commerciales |                                               |
| 1          | 18                       | 22                    | 218                     | 96               | 69.4           | 30.6             | 10.0                                          |
|            | 20                       | 22                    | 234                     | 95               | 71.1           | 28.9             | 10.8                                          |
| 2          | 20                       | 26                    | 267                     | 134              | 66.6           | 33.4             | 10.1                                          |
|            | 22                       | 26                    | 280                     | 90               | 75.7           | 24.3             | 10.7                                          |
| 3          | 22                       | 33                    | 242                     | 92               | 72.5           | 27.5             | 7.2                                           |
|            | 24                       | 33                    | 266                     | 113              | 70.2           | 29.8             | 8.1                                           |
| 4          | 24                       | 35                    | 397                     | 267              | 59.8           | 40.2             | 11.4                                          |
|            | 26                       | 35                    | 362                     | 183              | 66.4           | 33.6             | 10.3                                          |

### Conclusions préliminaires.

Les résultats indiquent que les mailles de 18 mm. en usage chez les crevettiers belges, retiennent un trop grand pourcentage de crevettes immatures et qu'on peut les élargir sensiblement sans devoir craindre une perte appréciable de crevettes à taille commerciale.

Néanmoins, avant de pouvoir se prononcer définitivement à ce sujet, il serait souhaitable que l'expérience avec le filet à mailles de 26 mm. et peut-être avec de plus larges encore, soit continuée jusqu'à ce qu'on obtienne un résultat nettement négatif. C'est à ce moment seulement que l'on sera à même de décider

quelle largeur il faut retenir pour la réglementation des mailles du chalut crevettier.

Il va de soi que la Belgique seule ne pourra remédier à la crise crevettière et qu'il lui faudra le concours des autres pays intéressés dans la pêche crevettière sur la côte est de la Mer du Nord, notamment la Hollande, la France et l'Allemagne, car sans le concours de ces pays tous nos efforts, pour améliorer le rendement de cette pêche, seraient vains. CH. GILIS.

Voir Comité Atlantique, p. 91. Note préliminaire sur les Crevettes des Côtes du Maroc, par CL. MAURIN.

## MOLLUSCA

### Oyster.

#### Production and Setting of Oyster Larvae in the Rivers Roach and Crouch during 1951, with a Note on Production in previous Years.

It was anticipated that the production of oyster larvae, particularly in the River Crouch, would be lower than in 1950 because of losses of breeding stock during the winter of 1950—51. A spring survey had shown that in the highest reaches of that river the mortality among oysters of all ages was at least 70% while on grounds at Fambridge and Purleigh Shore losses were estimated at 40% and 33% respectively. (Figure 1).

The weather during the winter had been mild but the rainfall was greater than in any of the last four winters, with the result that the salinity in the upper part of the river was much reduced. Frequent samples taken at low water at Fambridge showed that the salinity dropped below the safe level of 20‰ at the beginning of February and remained below this value until mid-April. The lowest recorded was 11.15‰ on 26. February. Even at high water at Burnham the salinity was much lower than normal, varying between 26.5 and 29.5‰ over the same period. This reduced salinity caused actual losses of oysters and also adversely affected the survivors. At the end of the

summer as many as 50% were found to be "chambered" to at greater or lesser extent.

The summer breeding season was also wet. The rainfall from 1. June to 14. September totalled 216 mm. compared with 140 mm. from 14. June to 14. September 1948, the previous highest since 1947. During May the temperature varied between 10 and 12°C. until late in the month when it reached and exceeded 13°C. By 3. June the mean daily temperature had risen above 17°C. but it only remained above this value for a few days. It was not until 28. June that it remained above it for any prolonged period. (Figure 2).

#### Larval Production.

The larval production in the River Crouch was lower than in 1950 but the very great reduction in numbers cannot be attributed entirely to the losses experienced among the stock oysters. The numbers of larvae present were similar to those occurring in 1948 and 1949, though in these years stocks were undoubtedly lower than at the beginning of the 1951 season. In the river Roach on the other hand, numbers of larvae were approximately the same as in 1950. It is probable that the intensive restocking carried out by ourselves and a local company more than compensated for the losses incurred. (Figure 1).



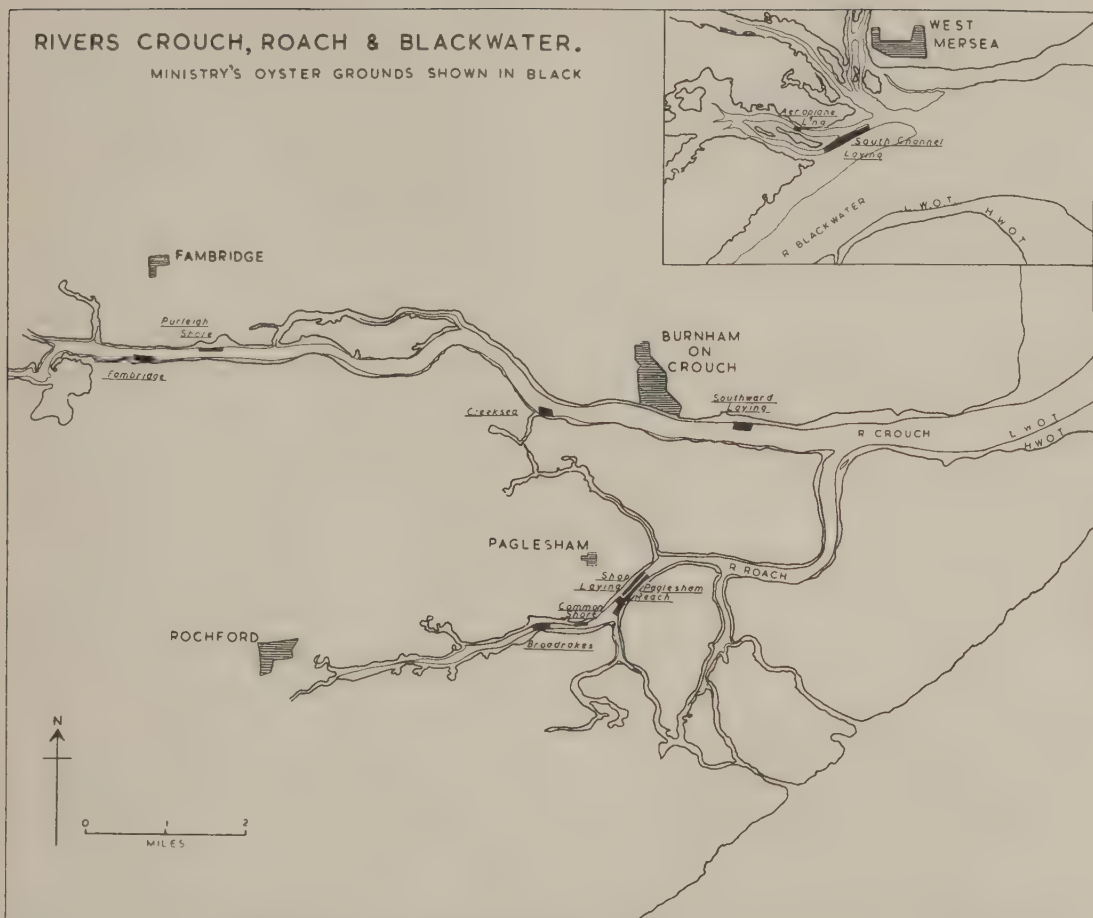


Figure 1. Map of Rivers Roach and Crouch, with inset, the mouth of the river Blackwater, showing the Ministry's oyster grounds.

The larvae failed to grow; of over 17,000 examined in the course of routine sampling only 8 exceeded 0.24 mm. in diameter. These larvae were taken in the river Roach where 10 "eyed" larvae were seen, 8 at 0.25 mm. and 2 at 0.24 mm.; the vast majority of the larvae (95%) measured only 0.20 mm. or less in diameter. In the river Crouch an even greater percentage (97%) were of this size or below it. Mortalities were high and sudden; empty larval valves occurred in great numbers in the samples. At the time of the peak liberation on 2. July the 100-litre sample from Roach Mouth contained 30 empty paired valves for every 100 living larvae.

#### Spatfall.

Counts of larvae had shown that there was no hope of obtaining a spatfall and only one spat was recorded. This settled on a slate collector in the river Crouch close to the mouth of the Roach. These slates which have been set out at fixed points in the two rivers each summer and changed at weekly intervals are of limited value in assessing spatfall so counts were also made of settlement on collectors. These collectors of the egg-box type had been put out in groups of 40 at various places in the two rivers but the settlement averaged only 2 spat per collector compared with 250 in 1950. The average includes settlement on collectors

## Nannoplankton.

Reference to Figure 2 shows that the population of 2 to 10  $\mu$  flagellates was very low. We can state with certainty that the population was considerably lower than in 1950 and that it remained low throughout the breeding season. In 1950 there were well marked peaks in the population which, perhaps by chance, were associated with the peak liberation of oyster larvae. These peaks of flagellate populations were associated also with rainfall and sunshine. The 1951 season was not particularly dull but nevertheless there were no nannoplankton outbursts associated with bright periods, neither were they associated with rainfall. It is possible that the nutrient salts necessary for their growth and multiplication were lacking, the majority of these salts having been leached out from the land by the heavy rainfall earlier in the season. It is noteworthy that the population pattern was similar in both rivers though the numbers of feeding larvae were very different. It is therefore unlikely that the low numbers occurring in both rivers during the first week in July were produced as a result of the grazing activities of the oyster larvae. It is much more likely that it was due to the lack of nutrient material, low temperatures and lowered salinity.

The settlement of other sedentary organisms was also sparse. Examination of the settlement slates showed that *Dendrodoa grossularia*, which is normally common, only occurred twice. Similarly *Crepidula fornicata*, normally abundant, was only recorded once. *Elminius modestus* continued to settle but on a reduced scale, the total number settling being less than half that of 1950. That these three animals, with a mode of feeding similar to that of the oyster, all appeared to suffer equally suggests either a shortage of something specific in the way of nutrient, or, perhaps, the liberation of weakened larvae from parents in poor condition.

However, there was no oyster spatfall on the south-west coast of England and though all the oysters on the east coast were in poor condition as a result of the wet season, there is evidence that the Cornish oysters were unaffected. No nannoplankton observations were made over the Cornish beds, but it seems probable that deficiencies in this factor were common to both grounds. Either some specific food organism was not present in sufficient quantities, or there was a development of some form toxic to the larvae.

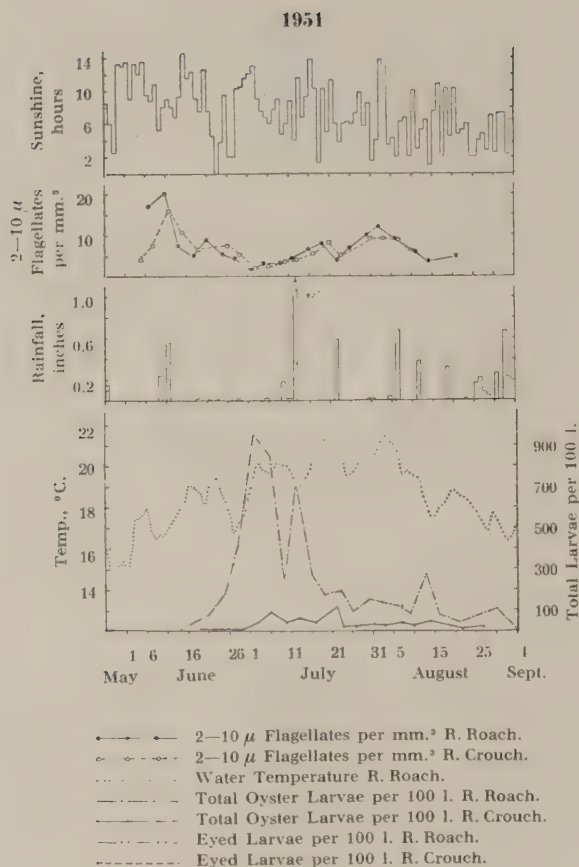


Figure 2. Graphs showing the mean daily water temperature at Paglesham in the river Roach, the total numbers of oyster larvae per hundred litres and production of 2-10 $\mu$  flagellates in the rivers Roach and Crouch. Also sunshine and rainfall at Burnham during the 1951 breeding season. Eyed larvae negligible and not shown.

sited at Roach Mouth, a new station, where settlement was the highest, namely 15 spat per collector. This site had been chosen because it had been found over a period of years that the density of larvae at low water was greater at this point than at any other. Certainly settlement here was much more dense. In the upper reaches of the river at Common Shore and Broadrakes there were only 1.4 and 0.1 spat per collector while in the Crouch at Purleigh Shore and Fambridge settlement was 0.4 and 0.0 respectively.

Comparison with results obtained in previous years does not afford any explanation for the failure of the spatfall though the records of larval production have shown that until this year there was a steady improvement in both the numbers of larvae present and the spatfall during the seasons from 1947 onwards.

In the summer of the latter year stocks of oysters were very low as a result of the heavy mortality experienced during the preceding severe winter and it was to be expected that the numbers of swimming larvae would also be low. This was the case though, as the station at Burnham was not opened until the end of June, observations were not made during the whole of the breeding season. At this time 100-litre pump samples were taken at various places in the two rivers, and the distribution of the larvae was found to be patchy. Nevertheless, it was found that the patches of larvae did not disperse to any great extent as the Rivers Roach and Crouch are, in fact, an embanked arm of the sea in which the tide performs a twice daily piston-like movement with little loss of water, or larvae, out to sea. Having established this, it was possible, in later years, to standardise the sampling technique; samples being taken at a fixed state of the tide at three widely spaced stations in each river. The means of each set of three give an index of the larval populations.

The winters of 1947-48, 1948-49 and 1949-50 were very mild and losses of oysters were slight. There was therefore a gradual build up of stocks in the two rivers, particularly in the Roach, where restocking was carried out. This improvement in the stocks was reflected in the increased numbers of larvae present in the water during each successive season.

It was of interest to note the relation between water temperature and larval liberations, particularly in 1948 when the summer was cool and wet except for one hot bright period at the end of July and beginning of August. An abrupt rise in water temperature from 18 to 23°C. was associated with a mass liberation of oyster larvae of which a high proportion grew to settling size. A similar state of affairs existed in 1950, though then the abrupt rise in temperature occurred at the beginning of June and was followed by a mass liberation of larvae which again grew well. As was expected from numbers of eyed larvae present in the samples, there was a very heavy spatfall. Settlement estimated from numbers of selected shells in

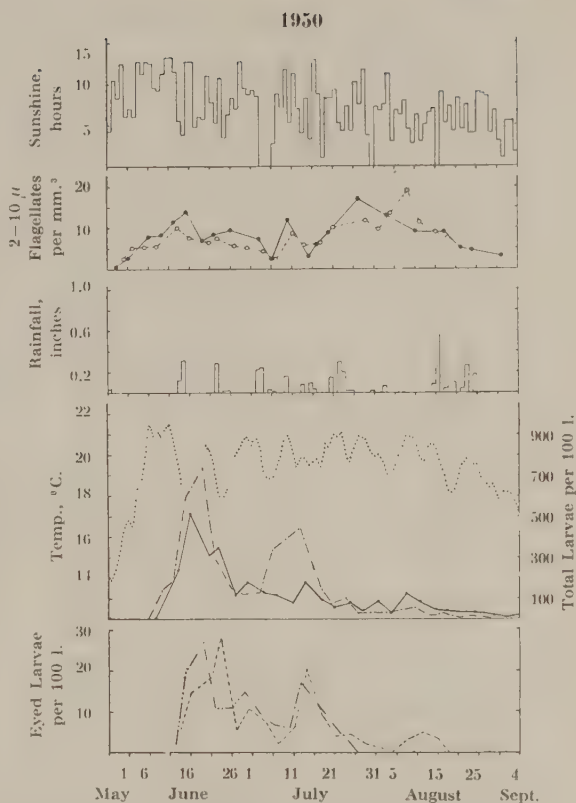


Figure 3. Graphs showing the mean daily water temperature at Paglesham in the river Roach, the total numbers of larvae per hundred litres, and numbers of eyed larvae per hundred litres and production of 2-10 $\mu$  flagellates in the rivers Roach and Crouch. Also sunshine and rainfall at Burnham during the 1950 breeding season. Key as in Figure 2.

the two rivers gave the following results: — In 1947, 0.9 spat per shell; 1948, 1.8 spat per shell; 1949, 4.5 spat per shell and 1950, 20.5 spat per shell.

Though occasional observations had previously been made on the populations of nannoplankton organisms no positive effort had been made to relate their abundance to the growth of the larvae. In 1950 however, at the same time as the pump samples, water samples were taken. These were collected in thermos-flasks, thus avoiding damage to the nannoplankton organisms by sudden changes in temperature or by exposure to bright sunlight. Flagellates collected in this way were still active after a period of eight hours. The samples were concentrated (COLE & KNIGHT-JONES, 1951) and



counts made on a haemocytometer at a magnification of ca.  $\times 400$ .

These regular observations showed that there were abrupt changes in the flagellate population and that in some cases these may be associated with sunshine and rainfall. A short dull spell of two days results in a rapid diminution of the number of flagellates present; while if there is a heavy rainfall during the dull spell there is often a sudden outburst of nannoplankton organisms as the weather improves. Two of the peaks in the flagellate population occurred at times where oyster larvae were most abundant (graph, Figure 3) and this is considered to be one of the main reasons why development was so rapid and survival so good during the 1950 season.

#### Reference.

COLE, H. A. & KNIGHT-JONES, E. W., 1951. "Quantitative estimation of marine nannoplankton". *Nature*, London, **164**, 694.

G. DUNCAN WAUGH.

### Larvae and Spatfall of Oysters in the Oosterschelde (Holland) in the Year 1951.

Following the usual observations on the number and size of oyster larvae in the water of the Oosterschelde (Holland), in our efforts to aid the local oyster industry by predicting the intensity of setting, plankton samples were collected and examined in the year 1951. The methods used in collecting samples of 100 litres of water and in counting and measuring the larvae in such samples have been described previously (KORRINGA). The samples were collected at the station Yersche Bank in the centre of the basin of the Oosterschelde. Daily samples were taken at high slack water from 12. June up to 23. June inclusive; twice-daily samples were taken at high slack and low slack water, in the height of the season from 25. June up to 31. July inclusive. To follow the events in the remainder of the season, which is, as a rule, of very limited practical importance, sampling once a day was carried through from 1. August up to 31. August inclusive. For technical reasons it was impossible to collect plankton samples on Sundays. Where two plankton samples were taken in a day, the average number of larvae in each size-class has been computed per 100 litres, and is depicted in the diagram. The intensity of setting

was measured by exposing lime-coated glass slides at an angle of  $45^\circ$  in concrete containers for periods of 3 days, in the manner described by HAVINGA and KORRINGA (see *Ann. Biol.* VII, p. 157).

Our predictions, based on the number and size of the larvae, and on water temperatures, ran as follows:—

In the general outlook (based on the size of the oyster stock and on lunar periodicity), a fair production of larvae was predicted, which would lead, in a not too cold season, to a reasonably good set. A maximum in the production of larvae was predicted about 29. June, provided water temperatures were normal at that time.

No oyster larvae were observed about 12. June, the first larvae making their appearance about 15. June. On 21. June modest numbers of young larvae were reported to occur in the Oosterschelde. No spatfall was yet to be expected. On 25. June the number of young larvae was given as fair. Large larvae being still very scarce and water temperatures being only  $18^\circ\text{C}$ ., spatfall could not yet be announced. On 28. June the number of larvae was said to be fair (300 per 100 litres of water) but low water temperatures ( $16$  to  $17^\circ\text{C}$ .) were said to slow up larval development, so that spatfall could not yet be expected. On 2. July it was reported that large numbers of young larvae had made their appearance, notwithstanding the cool weather. The very first spatfall, not yet of commercial interest, was announced. On 4. July a further increase in the number of larvae and a somewhat higher water temperature were said to co-operate in improving spatfall prospects, so that the setting intensity would soon improve. The large number of larvae counted early in July (up to 1000 per 100 litres of water on 2. and 3. July) corresponded well with our long-term prediction, for at low water temperatures spawning is always postponed a few days. On 6. July the set was said to be fair and on 10. July the arrival of new young larvae was said to stabilize setting prospects. Spatfall intensity was described as reasonable, but a really profuse setting could not yet be announced. On 14. July spatfall was said to be moderate only, but setting prospects were said to be improving as larval development was good considering the rather moderate water temperatures. On 18. July the set was said to be good at that moment and we expected it to remain of commercial interest for the next

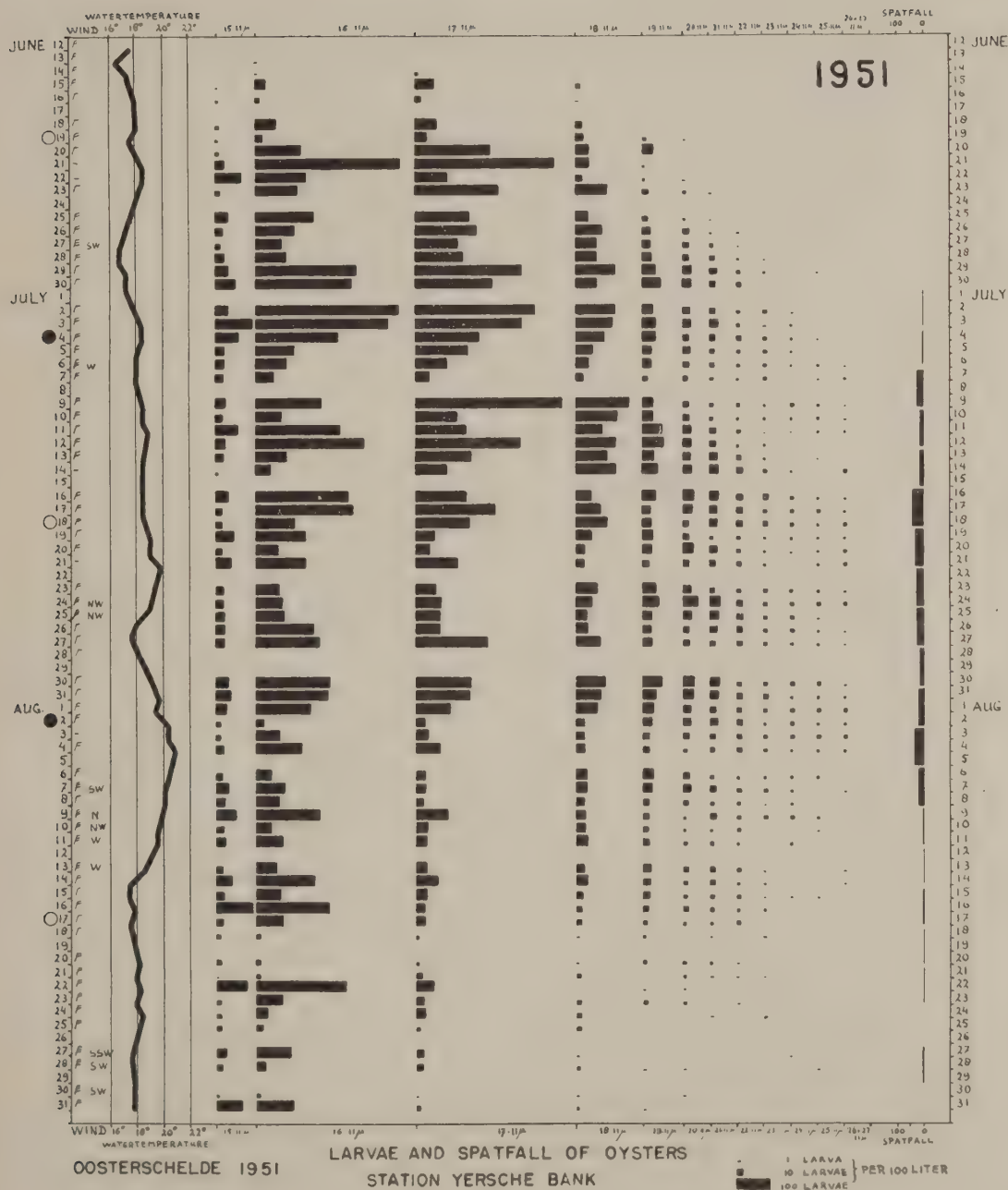


Figure 4.

days. On 24. July the set was still described as fair at that moment and for the next few days. On 1. August larvae were reported as still numerous for the time of the year (500 per 100 litres of water) and larval development being still rather good, the set was said to continue for the time being. On 9. August it was reported that the number of larvae decreased and that the spatfall to come would be considerably poorer than in the previous days and weeks. On 16. August spatfall prospects were said to be very poor.

It can be derived from the diagram (Figure 4) that the measured intensity of setting agreed well with our predictions. The total production of larvae has indeed been fair with high figures around 2. and 3. July. The number of larvae did not show great ups and downs in the year 1951, and the same can be said of the water temperature in June and July. In the period of high numbers of oyster larvae (21. June up to 18. July) water temperatures remained under 19°C. Considering these temperatures, larval development was surprisingly good, and rather high numbers of full-grown larvae, ready to settle down, were counted. A smaller maximum in larval production, occurring late in July hit somewhat higher water temperatures, which led to a further increase in the number of full-grown larvae and to a rather good set early in August. Setting of commercial interest took place from 6. July up to 8. August, in which the periods 15. to 18. July and 2. to 5. August inclusive were the best. Very high peaks in setting intensity did not occur in the year 1951.

The results obtained by the oystermen working with tile collectors were good in the year 1951, many collectors bearing over 50 spat in autumn. Peculiarly enough shell collectors immersed in the very same period as the tiles, usually led to rather disappointing results. Considering the number of full-grown larvae, shell collectors should in our experience collect at least 1 oyster per 2 mussel shells. In reality we often found 1 young oyster per 5 to 10 shells in autumn, and shells bearing over 2 spat were rare. This is too little to pay the expenses since mussel shells have been sold at Hfl. 15.- per m.<sup>2</sup> in 1951, and as only part of the newly settled spat will survive. Observations in the summer season taught us that early mortality has not been the reason for the small numbers of spat on the mussel shells. The water of the Oosterschelde has been unusually "thick"

throughout the summer of 1951, due to intense growth of small algae and to large quantities of detritus, which may have reduced the time mussel shells remained clean enough for the attachment of oyster larvae. It seems, however, hard to explain why tile collectors did not suffer appreciably from these conditions in the year 1951.

As it was again our experience that our spatfall predictions can be said to give a reliable outlook for the setting prospects (KORRINGA<sup>1</sup>), it is considered that our methods are satisfactory for this purpose.

<sup>1</sup>) KORRINGA, P., 1951. "Larvae and spatfall of oysters in the Oosterschelde (Holland) in the year 1950." Ann. Biol., Vol. VII (1950), pp. 156—158.

P. KORRINGA.

## Scallop.

### Pétoncle (*Chlamys varia* L.).

Le Pétoncle est l'objet d'une pêche active en divers points de la côte française mais le gisement le plus important se trouve le long de la côte NE. de l'île de Ré où l'on distingue deux bancs, le banc du Bucheron et le banc de la Flotte.

Des observations périodiques ont été entreprises sur ces bancs en 1951 par le laboratoire de La Rochelle et plus de 14,000 de ces coquillages ont été mesurés. Les résultats étant sensiblement comparables dans ces deux stations nous ne rendons compte ici que des données recueillies sur le banc du Bucheron où l'on s'est efforcé, par l'examen des anneaux d'hiver et le résultat des mensurations, de déterminer l'évolution du stock au cours de l'année, sa croissance et sa composition par classes d'âge.

### Composition du Stock.

L'examen des coquilles a montré que sur 85% d'entre elles l'arrêt de croissance hivernal se traduisait par un anneau parfaitement distinct et qu'il était par suite possible de distinguer des groupes I à V en plus d'un groupe 0 issu de la ponte de l'année (Tabl. 1).

La taille moyenne de ces divers groupes, calculée en Novembre sur 901 individus, était de:

| Groupe:  | 0  | I  | II | III | IV | V  |
|----------|----|----|----|-----|----|----|
| mm. .... | 10 | 32 | 40 | 42  | 46 | 48 |



Tableau No. 1. Taille de chaque Groupe

| le 6. XI. 51.  |     |     |    |     |    |   |
|----------------|-----|-----|----|-----|----|---|
| Groupe:<br>mm. | 0   | 1   | II | III | IV | V |
| 5              | 25  | —   | —  | —   | —  | — |
| 10             | 120 | —   | —  | —   | —  | — |
| 15             | 36  | —   | —  | —   | —  | — |
| 20             | —   | —   | —  | —   | —  | — |
| 25             | —   | 42  | —  | —   | —  | — |
| 30             | —   | 282 | —  | —   | —  | — |
| 35             | —   | 276 | 6  | 4   | —  | — |
| 40             | —   | 13  | 40 | 43  | 3  | — |
| 45             | —   | —   | 5  | 41  | 40 | 2 |
| 50             | —   | —   | —  | 1   | 16 | 5 |
|                | 181 | 613 | 51 | 89  | 59 | 7 |

1000 (N = 901)

Le groupe I formait la plus grande partie des captures (61.3%) puis le groupe 0 (18.1%) et enfin les groupes II à V (20.6%) (Figure 5).

La pêche n'étant autorisée que de Novembre à Mars et le groupe 0 étant rejeté à la mer, le groupe I, tel qu'il ressort de l'analyse du stock de Novembre, représente un groupe qui n'a pas encore été pêché étant trop petit au cours de la précédente saison. Les groupes II à V représentent par contre des groupes qui ont subi l'action de la pêche au cours d'une à quatre campagnes et il est par suite possible de déduire du graphique de la Figure 5 que la classe 1949 a été déficitaire.

## Croissance.

Les données précédentes (Tableau 2) montrent que la croissance est très rapide au cours des deux premières années puis qu'elle se réduit ensuite très sensiblement. La Figure 6

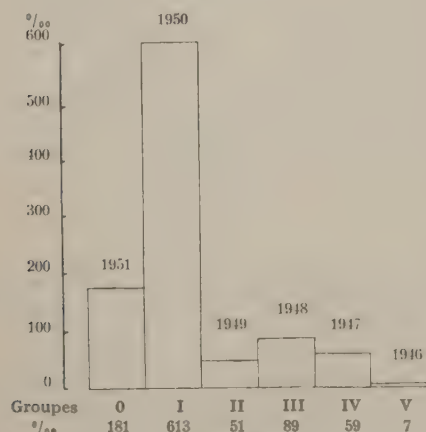


Figure 5.

Tableau 2. Tailles observées en 1951.

| mm.        | 5<br>II | 19<br>IV | 4<br>VI | 12<br>VII | 16<br>VIII | 4<br>X | 6<br>XI | 14<br>XII |
|------------|---------|----------|---------|-----------|------------|--------|---------|-----------|
| 1—5.....   | —       | —        | —       | —         | 23         | 79     | 3       | 5         |
| 6—10.....  | 96      | 10       | 8       | —         | —          | 233    | 75      | 59        |
| 11—15..... | 170     | 96       | 78      | 8         | 8          | 30     | 74      | 130       |
| 16—20..... | 35      | 53       | 169     | 108       | 53         | 16     | 4       | 32        |
| 21—25..... | 15      | 6        | 51      | 366       | 242        | 31     | 15      | 44        |
| 26—30..... | 49      | 56       | 60      | 124       | 208        | 158    | 132     | 125       |
| 31—35..... | 64      | 124      | 124     | 16        | 38         | 145    | 338     | 166       |
| 36—40..... | 173     | 221      | 159     | 87        | 107        | 71     | 129     | 143       |
| 41—45..... | 278     | 298      | 252     | 160       | 209        | 146    | 143     | 213       |
| 46—50..... | 113     | 131      | 98      | 123       | 100        | 86     | 82      | 79        |
| 51—54..... | 7       | 5        | 1       | 8         | 12         | 5      | 5       | 4         |
| Total..... | 1000    | 1000     | 1000    | 1000      | 1000       | 1000   | 1000    | 1000      |
| N.....     | 619     | 425      | 647     | 1411      | 720        | 653    | 1055    | 402       |

donnant l'évolution du stock présent en 1951 sur le banc confirme ces observations.

La ponte se situe en Juillet le groupe 0 apparaissant en Août et atteignant une taille modale de 12 mm. en Décembre (classe 1951). Cette taille correspond d'ailleurs à celle de la classe 1950 observée en Février et dont on peut suivre la croissance jusqu'à 33 mm. en fin d'année.

Quant aux classes plus âgées, si l'on excepte celle de 1949 dont la taille modale varie entre 30 et 40 mm., il est difficile de les discerner car leur croissance est réduite et la courbe de population est confuse entre 40 et 50 mm.

On peut cependant déduire des Tableaux 1 et 2 que la taille modale du Pétoncle est de:

| An      | 1/4 | 1/2 | 1  | 2  | 3  | 4  | 5  |
|---------|-----|-----|----|----|----|----|----|
| mm..... | 8   | 12  | 23 | 36 | 42 | 44 | 46 |

## Marquages.

700 marquages ont été réalisés en Juillet-Août et 27 recaptures signalées dans les 3 à 7

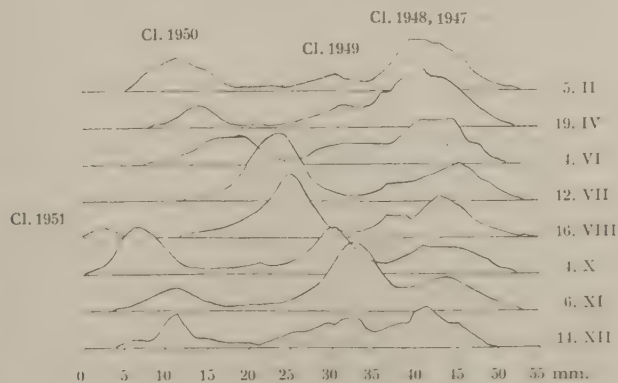


Figure 6.

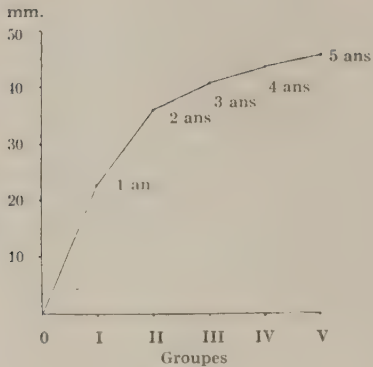


Figure 7.

mois qui suivirent. Ce faible taux de recaptures (7%) laisse supposer qu'une partie seulement des marques retrouvées ont été déclarées.

C'est au début de la saison de pêche que la plus grande partie des individus a été remise au laboratoire:

|          |          |         |         |      |       |
|----------|----------|---------|---------|------|-------|
| Novembre | Décembre | Janvier | Février | Mars | Total |
| 9        | 5        | 6       | 1       | 1    | 22    |

La croissance observée sur ces individus correspond à celle déduite de la Figure 6.

| Groupes | Nombre d'individus | Taille moyenne au marquage | à la recapture |
|---------|--------------------|----------------------------|----------------|
| I       | 13                 | 27 mm.                     | 35 mm.         |
| II      | 3                  | 36 mm.                     | 40 mm.         |
| III+    | 6                  | 42 mm.                     | 43 mm.         |

Remarque: L'exécution de ce travail a été combinée avec le relevé des données hydrologiques dont le résultat est donné par ailleurs (Pertuis Breton).

J. AUDOUIN et R. LETACONNOUX.

## Mussel.

### Epidemiological Observations on the Mussel Parasite *Mytilicola intestinalis* STEUER, carried out in the Netherlands 1951.

#### Waddensea.

Scrutiny of a great number of samples of mussels collected in the Dutch Waddensea confirmed the finding of the year 1950, that the mussels of the beds and parks west of longitude  $6^{\circ}23'$  E. are completely free of the parasitic copepod *Mytilicola intestinalis* STEUER. A nidus of parasites is to be found in the waters

around the German isle of Borkum, and the extreme eastern part of the Dutch Waddensea is to be considered as a transition area. Frequent sampling from the mussels living in this transition area revealed that considerable numbers of *Mytilicola* are only to be found in the mussels of the Eemswadje, situated due south of the isle of Borkum. The mussels from the natural beds of the Schild and the Spruite, systems of creeks situated S. and SW. of the isle of Rottum, appeared to be only very lightly infected with *Mytilicola*. As a rule 2% or less of these mussels appeared to lodge a single *Mytilicola*, and never did I find two or more parasites in one mussel. The Schild and the Spruite therefore cannot be considered as niduses of *Mytilicola*, for few, if any larvae will be produced here. This *Mytilicola* population is not self-supporting. No *Mytilicola* have been found in samples of mussels collected in the Eilanderbalg, situated E. and SE. of the isle of Schiermonnikoog.

There was virtually no difference in the *Mytilicola* situations of 1950, spring 1951, and autumn 1951. Apparently the parasite makes no headway in these waters. The fact that the percentage of mussels bearing *Mytilicola* in the Schild does not differ noticeably from that in the Spruite, situated further west, indicates that *Mytilicola* does not migrate westwards over the shallow tidal flats. I deem it more probable that the specimens encountered once entered the creeks as larvae carried on the incoming tide from the adjacent deeper waters of the North Sea where they had arrived earlier on the ebb, presumably from the Borkum district. Considering that all adult *Mytilicola* die off in early summer, further increases in the number of *Mytilicola* are not to be expected in the transition area of the Waddensea. As long as these conditions prevail, the important mussel districts in the western part of the Waddensea do not run a serious risk of being invaded by *Mytilicola*.

#### Zealand.

In the Zealand waters, situated in the SW. part of the Netherlands, *Mytilicola* was found in enormous numbers in the year 1950. In many lots we counted over 10 parasites per mussel in that year. Serious mortality occurred among such heavily infected mussels, and those which did survive showed both a poor growth and a poor condition. Samples taken



Figure 8. Number of *Mytilicola* per mussel and percentage of mussels infested in July 1950, when the *Mytilicola* population reached its highest peak and mortality among the mussels was high. Degree of black filling of circles indicates percentage of mussels infested; vertical lines average number of *Mytilicola* per mussel.

throughout the winter season 1950–1951 confirmed the finding in the winter of 1949–1950 that *Mytilicola* is inactive in winter at water temperatures under about 8°C. They then do

not grow appreciably, do not reproduce (female specimens carrying egg-pockets are not seen in winter) and presumably have little, if any, ill effect on their hosts at low temperatures.



**Table 3. Water Temperature in the Basin of the Oosterschelde, °C.**

|                | 1950 | 1951 | Average<br>1921—1939<br>incl. |
|----------------|------|------|-------------------------------|
| January.....   | 3.5  | 2.5  | 3.0                           |
| February.....  | 3.8  | 3.9  | 2.9                           |
| March.....     | 6.4  | 4.6  | 4.9                           |
| April.....     | 8.6  | 8.1  | 8.5                           |
| May.....       | 12.9 | 12.1 | 13.3                          |
| June.....      | 18.9 | 17.2 | 16.9                          |
| July.....      | 20.0 | 19.0 | 19.1                          |
| August.....    | 19.5 | 18.9 | 18.8                          |
| September..... | 15.6 | 17.3 | 16.6                          |
| October.....   | 11.8 | 12.1 | 12.1                          |
| November.....  | 7.1  | 10.3 | 7.1                           |
| December.....  | 3.5  | 5.8  | 3.6                           |

Though the number of *Mytilicola* remained constant in the winter months, the mussels which survived the 1950 disaster recovered gradually. They resumed the production of byssus-threads and their general condition improved somewhat.

Sampling was carried out very frequently in the spring of 1951, because a resumption of reproduction, soon followed by the general dying off of the hibernated specimens of *Mytilicola*, was found to occur in the spring of 1950. In the year 1950 *Mytilicola* reproduction began in March and was in full swing as early as April. Many of the larvae produced settled then in mussels of any age. Late in May 1950 the hibernated adult *Mytilicola* disappeared, their life cycle being completed, which led to a temporary reduction in the Zealand *Mytilicola* population. Very soon, however, the young generation grew up and began to participate in reproduction, which ultimately led to the 1950 disaster (Figure 8).

**Table 4. Characteristic Events in 1951.**

| Plot 119 Grevelingen.     |                        | <i>Mytilicola</i> per mussel |                     |     |          |
|---------------------------|------------------------|------------------------------|---------------------|-----|----------|
| Date of sampling          | Size<br>mussels<br>mm. | %<br>infested                | ♀ (bearing<br>eggs) | ♂   | juvenile |
| 19. March ..              | 45                     | 100                          | 4.2 (—)             | 5.5 | 3.5      |
| 2. May ....               | 45                     | 100                          | 4.7 (2.0)           | 6.1 | 1.5      |
| 1. June....               | 52                     | 95                           | 2.4 (1.0)           | 5.4 | 0.5      |
| 9. July. .                | 54                     | 70                           | 0.1 (0.05)          | 2.0 | 0.4      |
| 8. August..               | 54                     | 65                           | 0.3 (0.05)          | 1.2 | 1.8      |
| Plot 13 Herkingsche Bank. |                        |                              |                     |     |          |
| 29. March ..              | 47                     | 95                           | 1.6 (—)             | 3.2 | 2.2      |
| 2. May ....               | 50                     | 80                           | 1.0 (0.4)           | 2.1 | 1.1      |
| 1. June....               | 50                     | 65                           | 0.7 (0.2)           | 1.0 | 0.9      |
| 9. July. .                | 52                     | 55                           | 0.2 (0.1)           | 1.0 | 0.3      |
| 8. August..               | 52                     | 55                           | 0.3 (0.1)           | 0.7 | 0.7      |

Both lots of mussels were in such a good condition late in August that they could be marketed.

The events of the year 1951 were very different. None of the female *Mytilicola* produced eggs in March, very few in April, and more in early May. We are inclined to ascribe this retardation to the lower water temperatures in the spring of 1951 (Table 3). Nevertheless the dying off of adult hibernated *Mytilicola* began in May and continued in June. This ultimately led to a tremendous reduction of the Zealand *Mytilicola* population. Many lots of mussels moderately or even heavily infected throughout the winter, lost their parasites almost completely. (Table 4). Only specimens which hibernated as juveniles and the few of the first 1951 generation remained. As soon as the number of parasites per mussel decreased noticeably the condition of the latter started to improve. Even the poorest mussels recovered, and soon resumed growth and fattening. The mussel farmers were pleasantly surprised to find that

**Table 5. Correlation between the Number of *Mytilicola* and the Condition of Mussels.**

| Nature of the mussels                | Group | Number of <i>Mytilicola</i><br>per mussel | Number of mussels in<br>this group | Condition<br>index |
|--------------------------------------|-------|-------------------------------------------|------------------------------------|--------------------|
| A                                    |       |                                           |                                    |                    |
| First class consumption mussels from | 1     | 0— $\frac{1}{2}$                          | 16                                 | 147.0              |
| plot 15 Hammen,                      | 2     | 1—2 $\frac{1}{2}$                         | 15                                 | 144.2              |
| O.S.W.D.                             | 3     | 3—5 $\frac{1}{2}$                         | 18                                 | 114.9              |
| Shell 53—57 mm. incl.                | 4     | 6—10 $\frac{1}{2}$                        | 10                                 | 112.4              |
|                                      | 5     | 11—15 $\frac{1}{2}$                       | 1                                  | 99.7               |
| B                                    |       |                                           |                                    |                    |
| Half grown mussels from              | 1     | 0— $\frac{1}{2}$                          | —                                  | —                  |
| plot 182 Engelsche Vaarwater,        | 2     | 1—2 $\frac{1}{2}$                         | 11                                 | 127.4              |
| O.S.W.D.                             | 3     | 3—5 $\frac{1}{2}$                         | 26                                 | 121.2              |
| Shell 49—54 mm. incl.                | 4     | 6—10 $\frac{1}{2}$                        | 28                                 | 112.6              |
|                                      | 5     | 11—15 $\frac{1}{2}$                       | 14                                 | 87.6               |
|                                      | 6     | over 16                                   | 10                                 | 70.6               |
| C                                    |       |                                           |                                    |                    |
| Small size marketable mussels from   | 1     | 0— $\frac{1}{2}$                          | 5                                  | 129.1              |
| plot JK Rengerskerk,                 | 2     | 1—2 $\frac{1}{2}$                         | 17                                 | 128.5              |
| O.S.W.D.                             | 3     | 3—5 $\frac{1}{2}$                         | 30                                 | 117.4              |
| Shell 52—55 mm. incl.                | 4     | 6—10 $\frac{1}{2}$                        | 34                                 | 103.9              |
|                                      | 5     | 11—15 $\frac{1}{2}$                       | 13                                 | 94.8               |
| D                                    |       |                                           |                                    |                    |
| Small size marketable mussels from   | 1     | 0— $\frac{1}{2}$                          | —                                  | —                  |
| plot 67 Zandkreek.                   | 2     | 1—2 $\frac{1}{2}$                         | 5                                  | 120.3              |
| Shell 50—55 mm. incl.                | 3     | 3—5 $\frac{1}{2}$                         | 9                                  | 101.1              |
|                                      | 4     | 6—10 $\frac{1}{2}$                        | 22                                 | 92.5               |
|                                      | 5     | 11—15 $\frac{1}{2}$                       | 11                                 | 88.7               |
|                                      | 6     | over 16                                   | 28                                 | 77.1               |

These analyses have been carried out in the month of December 1951. Mussels of about equal length were taken from a commercial sample. The number of *Mytilicola* per mussel was determined, male and juvenile specimens being counted as  $\frac{1}{2}$  on account of their smaller size. The condition index was obtained as  $1000 \times$  the dry weight per mussel (g.) divided by the volume of the shell cavity (cc.).

the very poor mussels they relaid with little hope in the spring of 1951 yielded marketable mussels of good quality later in the year.

The number of female *Mytilicola* being rather small throughout summer, and the Zealand mussel population being of modest dimensions compared with that in 1950, *Mytilicola* did not get a chance to "explode" like it did in that fatal year 1950. Their number increased only gradually. However, in places where the water circulation is limited, which means a reduced larval dispersion, the number of *Mytilicola* rose rather alarmingly late in the summer. This led to high numbers of *Mytilicola* in August and September in the Zandkreek and the Geul, O.S.O.D. These mussels ceased the production of byssus-threads, soon failed to grow, and their general condition became poorer and poorer. They soon showed thin watery meats of the same red-brown colour as observed in the weak and dying mussels in 1950. In some very heavily infected lots of mussels mortality set in in September. Winter conditions reduced the parasite's activities again; their reproduction came to a standstill early in October, though some females carrying egg-pockets could be found into November, and those of the youngest generation hibernated as juvenile specimens. The mussels did not suffer appreciably in the winter season.

The year 1951 taught us that if the reproductive activities of *Mytilicola* are of little importance in spring, the dying off of hibernated individuals may lead to such a tremendous reduction of the population of parasites that the mussels suffer so little that they grow and fatten almost normally, even in a case where they were heavily infected before. We know now that a modest population of *Mytilicola*

combined with rather poorly stocked mussel beds may greatly reduce the damage done by this parasite. The presence of about 5 *Mytilicola* in a mussel of fair dimensions does not interfere seriously with its normal development, and will not lead to poor condition and death of the host. Danger threatens only when over 10 parasites live in one mussel during high water temperatures.

I consider that the fact that it was *Mytilicola* which caused the 1950 disaster, and not some mysterious disease raging simultaneously, is clearly demonstrated by such evidence as the recurrence of poor condition and mortality in any place where the number of parasites rose high in the year 1951, the rapid improvement of the condition of the mussels as soon as the parasites disappeared, and the close correlation between the number of parasites and the condition of the mussels in the years 1950 and 1951. Figures obtained through careful analysis of moderately infected mussels also demonstrated clearly that small numbers of parasites have an adverse effect on the condition of the host, though this does not lead to its death. (Table 5).

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The Areas and their Limits.























